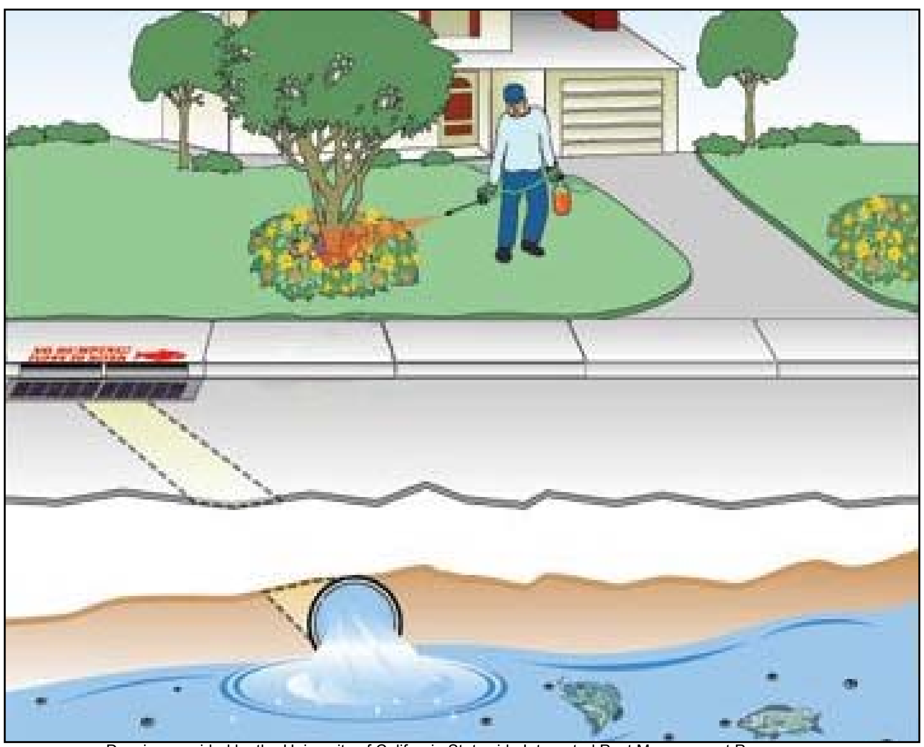
Diazinon and Pesticide-Related Toxicity in Bay Area Urban Creeks

Water Quality Attainment Strategy and Total Maximum Daily Load (TMDL)

Proposed Basin Plan Amendment and Staff Report



Drawing provided by the University of California Statewide Integrated Pest Management Program

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SUMMARY

This staff report provides the technical background and basis for a proposed amendment to the *Water Quality Control Plan, San Francisco Bay Region* (Basin Plan). Appendix A contains the text of the proposed Basin Plan Amendment. If adopted, portions of Basin Plan Chapter 3 (Water Quality Objectives) and Chapter 4 (Implementation Plan) would be revised to (1) establish a strategy to eliminate and prevent pesticide-related toxicity in Bay Area urban creeks, including a total maximum daily load (TMDL) that addresses pesticide-related water quality impairment, and (2) establish an implementation plan to achieve and support the strategy and TMDL. The strategy and TMDL are necessary because 37 Bay Area urban creeks are formally designated as impaired and pesticide-related toxicity also threatens other urban creeks.

PROBLEM STATEMENT

In the early 1990s, many Bay Area urban creek water samples were toxic to *Ceriodaphnia dubia*, an indicator organism used in laboratory tests to assess surface water toxicity and evaluate biological community responses. Studies found that the organophosphorus pesticide diazinon caused the toxicity. Diazinon concentrations throughout Bay Area urban creeks were often high enough to account for aquatic toxicity. In recent years, diazinon and water column toxicity occur less frequently in urban creeks, but they still occur.

Until 1999, substantial quantities of diazinon were applied in the Bay Area, but beginning in 2000, diazinon use began to decline substantially. The U.S. Environmental Protection Agency phased out most urban diazinon applications at the end of 2004. The phase-out increased the use of alternative pesticides and encouraged new pesticides to enter the marketplace. Some diazinon alternatives, particularly the pyrethroids, pose water and sediment quality concerns. Pyrethroids may already cause sediment toxicity in at least some Bay Area urban creeks.

Several agencies and organizations oversee pesticide use and pesticide discharges. Those with the broadest authorities include the U.S. Environmental Protection Agency and the California Environmental Protection Agency (including the California Department of Pesticide Regulation and the Water Boards). Gaps in pesticide regulatory program implementation allow pesticides to be used in ways that result in discharges that impair urban creeks and their habitat-related beneficial uses. Bay Area urban runoff management agencies and others are responsible for urban runoff discharges through National Pollutant Discharge Elimination System permits, but California law generally prohibits these agencies from regulating the registration, sale, transportation, or use of pesticides within their jurisdictions.

When pesticide-related toxicity is observed in Bay Area urban creek water and sediment, the creeks do not meet the Basin Plan's narrative objectives for toxicity, sediment, and population and community ecology. Water Board staff proposes adoption of a Basin Plan Amendment to establish a water quality attainment strategy and TMDL that addresses pesticide-related toxicity in Bay Area urban creeks. Because all Bay Area urban creeks can reasonably be assumed to receive pesticide discharges, and because implementation actions will be most efficient if applied region-wide, the strategy applies to all Bay Area urban creeks, including those not formally designated as impaired. The proposed Basin Plan Amendment includes regulatory provisions needed to meet water quality objectives and protect beneficial uses of urban creeks.

TMDL ANALYSES

The TMDL elements include a source assessment, numeric targets, a linkage analysis, and allocations. Pesticides, including diazinon, enter urban creeks primarily through urban runoff. Runoff contains pesticides as a result of pesticides being manufactured, formulated into products, and sold through distributors and retailers to businesses and individuals who apply them for structural pest control, landscape maintenance, agricultural, and other pest management purposes. Use of pesticide products sold over-the-counter and especially use by structural pest control professionals are among the greatest contributors to the pesticides in urban runoff. In the Bay Area, pesticides are most often used to control ants.

The numeric targets interpret the Basin Plan's narrative objectives in terms of quantitatively measurable water quality parameters. Proposed targets for pesticide-related toxicity are expressed in term of toxic units. They are 1.0 TU_a for acute toxicity and 1.0 TU_c for chronic toxicity, as defined in this report and determined through standard toxicity tests. The proposed diazinon concentration target is 100 nanograms per liter to be evaluated as a one-hour average. To protect aquatic life at all creek locations, each urban creek should meet the proposed targets at all locations, including those near storm drain outfalls where urban runoff enters receiving waters. These proposed targets are consistent with state and federal antidegradation policies.

The linkage analysis describes the links between pesticide sources and the proposed targets, which are linked to water quality standards. Pesticides are generally discharged to urban creeks after being applied outdoors and being washed away with urban runoff. Degradation, evaporation and deposition, and sediment transport are relevant pesticide fate and transport mechanisms.

The proposed targets are expressed in terms of toxic units and diazinon concentrations, and the TMDL and proposed allocations are also expressed in these terms. The total maximum load for each urban creek is allocated to the urban runoff that discharges into that creek. The allocations are the same as the numeric targets. While this allocation scheme may appear simple, the implementation plan reflects the fact that many parties bear responsibility for pesticide discharges to urban creeks. The TMDL includes an implicit margin of safety by relying on a generally conservative approach.

IMPLEMENTATION PLAN

The overarching strategy for eliminating and preventing pesticide-related toxicity in Bay Area urban creeks is to encourage pest management alternatives that do not threaten water quality and to discourage the use of pesticides that run off and threaten water quality. This can best be accomplished through the rigorous application of Integrated Pest Management techniques and the use of less toxic pest control methods. The implementation plan includes proposed actions that focus on (1) proactive regulation, (2) education and outreach, and (3) research and monitoring. The strategy will be reviewed approximately every five years.

Many entities share responsibility for the pesticide-related toxicity problem, and many entities must share responsibility for implementing actions to solve the problem. The role of the Water Board is to encourage, monitor, and enforce implementation actions, and to lead by example. Water Board staff proposes that the Water Board work with others responsible for pesticide use and oversight to encourage or require them to take actions that will reduce pesticide-related water quality threats.

Monitoring will be needed to track progress in implementing the proposed plan and meeting the proposed targets. Municipal urban runoff permits require dischargers to characterize their discharges, which necessarily involves monitoring toxicity and specific pollutants in receiving waters. Urban runoff management agencies will design and implement acceptable monitoring programs. The strategy includes a method to determine appropriate monitoring benchmarks for specific pesticides in water. The need for comprehensive pesticide-related water quality monitoring may be moderated by efforts to monitor other factors, which serve as surrogates or indicators of water quality conditions.

Since pesticide-related toxicity was discovered in urban creeks in the early 1990s, many parties have initiated efforts to confront the problem. The Water Board is implementing many pesticide-related actions through its ongoing programs using its existing authorities. By working to implement this water quality attainment strategy and TMDL, pesticide-related toxicity can be eliminated from Bay Area urban creeks, and future pesticide-related water quality risks can be avoided.

REGULATORY ANALYSES

Many Basin Plan provisions are considered regulations, and many of the changes contained in the proposed Basin Plan Amendment add regulatory provisions to the Basin Plan. To adopt these changes, the Water Board must complete several analyses pursuant to various laws, including California's Porter-Cologne Water Quality Control Act, Environmental Quality Act, and Administrative Procedures Act. This report contains these analyses, and explains the following conclusions: (1) adopting the Basin Plan Amendment would not result in any significant adverse environment effects, (2) the proposed Basin Plan Amendment is preferable to other options because it best meets the project objectives, (3) implementing the Basin Plan Amendment could place economic burdens on the regulated community and regulatory agencies to meet existing water quality standards, and (4) the proposed Basin Plan Amendment's regulatory provisions meet Administrative Procedures Act standards of review.

Problem Statement

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1. INTRODUCTION

This staff report provides the technical background and basis for a proposed amendment to the *Water Quality Control Plan, San Francisco Bay Region* (Basin Plan). Appendix A contains the text of the proposed Basin Plan Amendment. This report contains the results of staff analyses of pesticide impairment and sources, proposes allocations among sources, and sets forth a plan to implement the allocations. If adopted, portions of Basin Plan Chapter 3 (Water Quality Objectives) and Chapter 4 (Implementation Plan) would be revised to (1) establish a water quality attainment strategy to eliminate and prevent pesticide-related toxicity in Bay Area urban creeks, including a total maximum daily load (TMDL) that addresses pesticide-related water quality impairment (including impairment attributed to diazinon in urban creeks), and (2) establish an implementation plan to achieve and support the strategy and TMDL.

For purposes of this strategy, the term “pesticides” refers to substances (or mixtures of substances) intended for defoliating plants, regulating plant growth, or preventing, destroying, repelling, or mitigating pests that may infest or be detrimental to vegetation, humans, animals, or households, or be present in any agricultural or nonagricultural environment (see California Food and Agricultural Code §12753). The term “urban creeks” refers to freshwater streams that flow through urban areas, including incorporated cities and towns and unincorporated areas with similar land use intensities.

BACKGROUND

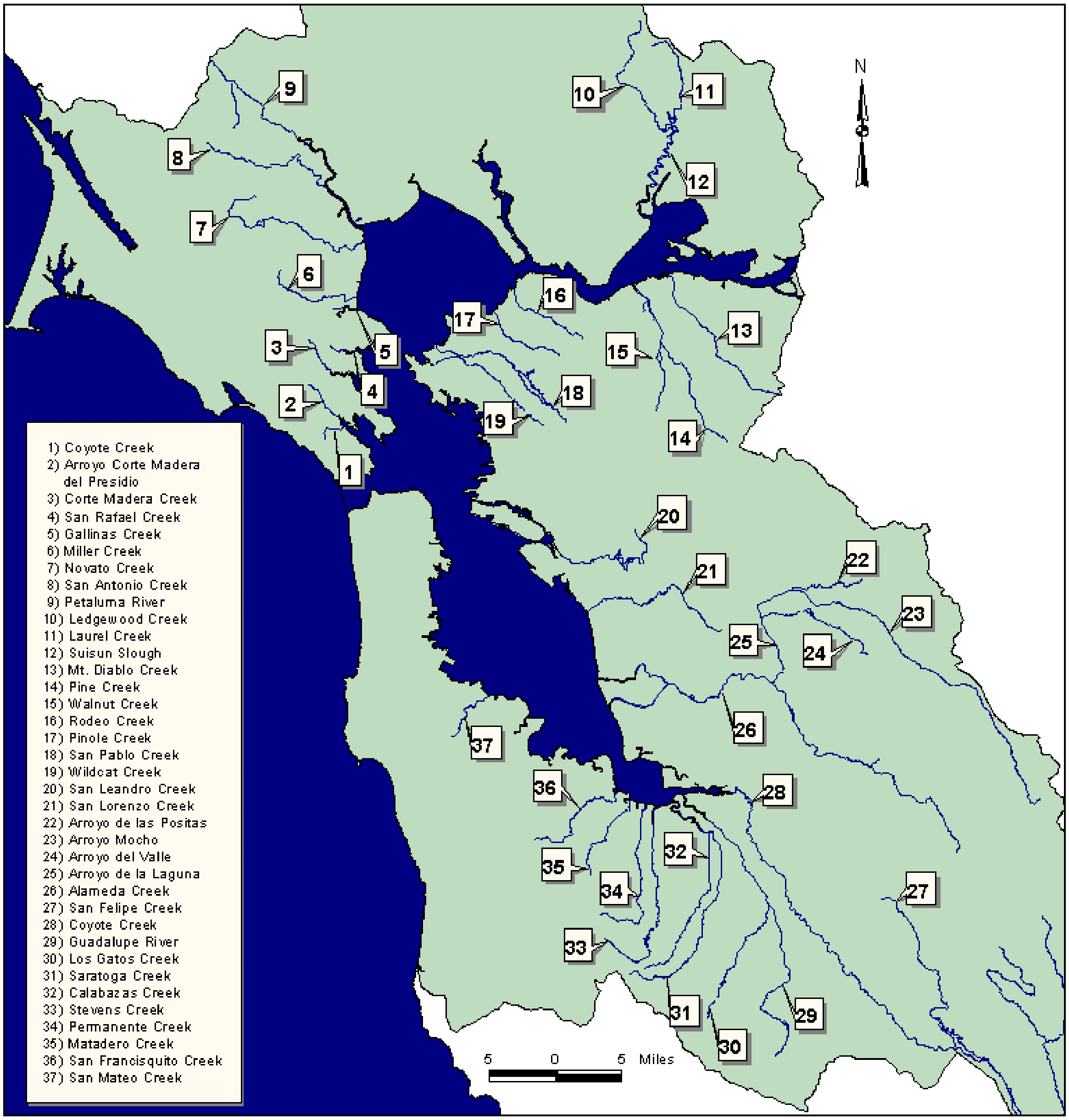
The Basin Plan contains water quality standards applicable to the San Francisco Bay region. Water quality standards define the water quality goals for each water body by designating the uses to be made of the water, setting the numeric or narrative water quality objectives necessary to protect the uses, and preventing degradation of water quality. Clean Water Act §303(d)(1) requires states to compile lists of “impaired” waters that do not meet water quality standards. In the Bay Area, 37 urban creeks appear on the list due to pesticide-related toxicity attributed to diazinon (SWRCB 2003). Toxic discharges jeopardize aquatic life in the creeks, impairing established beneficial uses, including warm and cold freshwater habitat. Table 1.1 lists the creeks on the “303(d) List” and their aquatic life-related beneficial uses. Figure 1.1 shows their locations.

Pursuant to Clean Water Act §303(d)(1), the Water Board is required to establish TMDLs for impaired creeks to reduce the pollutants responsible for impairment to levels that meet water quality standards. In March 2004, Water Board staff completed a final project report titled *Diazinon and Pesticide-Related Toxicity in Bay Area Urban Creeks Water Quality Attainment Strategy and Total Maximum Daily Load (TMDL)* (SFBRWQCB 2004f). That report summarized available information regarding diazinon and other pesticides in Bay Area urban creeks. This staff report follows up on that project report and reflects comments received from interested parties and new information obtained since March 2004. The strategy set forth in this report incorporates

TABLE 1.1
Urban Creeks on the "303(d) List" Due to Toxicity Attributed to Diazinon

	Relevant Beneficial Uses	
Urban Creek	**COLD**	**WARM**
Alameda County		
Alameda Creek	E	E
Arroyo de la Laguna	P	P
Arroyo de las Positas	E	E
Arroyo del Valle	E	
Arroyo Mocho	E	E
San Leandro Creek	E	P
San Lorenzo Creek	E	E
Contra Costa County		
Mount Diablo Creek	E	E
Pine Creek	E	E
Pinole Creek	E	E
Rodeo Creek		E
San Pablo Creek		E
Walnut Creek	E	E
Wildcat Creek		E
Marin County		
Arroyo Corte Madera del Presidio	E	
Corte Madera Creek	E	E
Coyote Creek	E	E
Gallinas Creek	E	E
Miller Creek	E	E
Novato Creek	P	P
San Antonio Creek	E	E
San Rafael Creek	E	E
San Mateo County		
San Mateo Creek	P	
Santa Clara County		
Calabazas Creek	E	E
Coyote Creek	E	E
Guadalupe River		E
Los Gatos Creek	E	E
Matadero Creek	E	E
Permanente Creek	E	
San Felipe Creek	P	E
San Francisquito Creek	E	E
Saratoga Creek	E	E
Stevens Creek	E	E
Solano County		
Laurel Creek	E	E
Ledgewood Creek	E	E
Suisun Slough		E
Sonoma County		
Petaluma River*	E	E

* Although this report addresses the Petaluma River's urban pesticide sources, it does not address the Petaluma River's other potential pesticide sources, such as agriculture.
E, Existing Beneficial Use
P, Potential Beneficial Use
COLD Cold Freshwater Habitat—Water that supports cold-water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife (including invertebrates).
WARM Warm Freshwater Habitat—Water that supports warm water ecosystems including preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife (including invertebrates).
Source: Basin Plan; SWRCB 2003.



NOTES: Figure prepared by Chieko Plotts. Although this report addresses the Petaluma River's urban pesticide sources, it does not address the Petaluma River's other potential pesticide sources, such as agriculture.

FIGURE 1.1
Urban Creeks on the "303(d) List" Due to Toxicity Attributed to Diazinon

a TMDL that addresses the formally designated impaired creeks. In addition, the strategy and TMDL address all other Bay Area urban creeks because evidence indicates that they are similarly impaired.

This staff report meets the requirements of the California Environmental Quality Act for adopting Basin Plan Amendments. The California Environmental Quality Act authorizes the California Resources Agency Secretary to exempt a state agency's regulatory program from preparing an Environmental Impact Report or Negative Declaration if certain conditions are met. The Resources Agency has certified the basin planning process to be functionally equivalent to the California Environmental Quality Act process. Therefore, this report is a Functional Equivalent Document and fulfills California Environmental Quality Act environmental documentation requirements.

REPORT ORGANIZATION

This report contains four main divisions: (1) "Problem Statement," (2) "TMDL Analyses," (3) "Implementation Plan," and (4) Regulatory Analyses. Each division contains several sections. The sections of the "Problem Statement" provide the basis for an impairment assessment and conclude with a project description. Each "TMDL Analyses" section provides an analytical component required for a TMDL. The "Implementation Plan" sections lay out how the water quality attainment strategy and TMDL is to be implemented. The "Regulatory Analyses" sections meet Administrative Procedures Act requirements for amending the Basin Plan.

The "Problem Statement" specifically includes the following sections:

1. "Introduction"—explains what this report is about.
2. "Water Quality Conditions"—describes toxicity and pesticide concentrations in Bay Area urban creeks.
3. "Pesticide Use Trends"—summarizes trends in diazinon use and other pesticide applications.
4. "Pesticide Oversight"—explains oversight roles of regulatory agencies and others.
5. "Project Description"—defines the impairment problem and the project proposed to solve it.

The "TMDL Analyses" include the following sections:

6. "Source Assessment"—identifies sources of pesticides in Bay Area urban creeks.
7. "Numeric Targets"—proposes targets to interpret the Basin Plan's narrative objectives and protect habitat-related beneficial uses.
8. "Linkage Analysis"—describes the links between pesticide sources and the proposed targets.
9. "Allocations"—allocates pesticide loads among sources (i.e., assigns responsibilities).

The "Implementation Plan" includes the following sections:

10. "Strategy and Proposed Actions"—identifies implementation goals and assigns implementation actions among responsible entities.
11. "Monitoring and Adaptive Management"—describes monitoring needs and adaptive use of new information.
12. "Early Implementation"—summarizes implementation activities already underway.

The "Regulatory Analyses" include the following sections:

13. "Environmental Impacts and Alternatives Analysis"—summarizes the conclusions of the environmental impact assessment and evaluates alternatives to the proposed Basin Plan Amendment.
14. "Economic Considerations"—considers economic factors relating to implementing the amendment.
15. "Administrative Procedures Act Standards of Review"—discusses compliance with the California Administrative Procedures Act and its standards of review.
16. "References"—provides references for documents cited throughout the report.

NEXT STEPS

The public is invited to review this staff report and the proposed Basin Plan Amendment. Water Board staff will respond to the comments received and consider changes as appropriate. Staff will then present the draft Basin Plan Amendment to the Water Board for consideration and possible adoption (authorized under California Water Code §13240).

Assuming the Water Board adopts the amendment, other agencies must also approve it before it becomes effective. First, the State Water Resources Control Board must consider the amendment (see California Water Code §13244), and if it approves it, the California Office of Administrative Law must review the regulatory provisions of the amendment. If the Office of Administrative Law approves the amendment, the U.S. Environmental Protection Agency must provide the final approval. Stakeholder comments and concerns will be considered at key milestones throughout this process.

KEY POINTS

- This report presents Water Board staff analyses and findings pertaining to establishing a strategy to eliminate and prevent pesticide-related toxicity from Bay Area urban creeks.
- The strategy includes a TMDL to address pesticide-related water quality impairment, including impairment attributed to diazinon in urban creeks.
- This report supports a proposed Basin Plan Amendment, which, if adopted, will establish the strategy and TMDL, including related implementation actions.
- If the Water Board adopts the amendment, it will be forwarded to the State Water Resources Control Board for consideration. Then, if approved, the amendment will be sent to Office of Administrative Law and finally to the U.S. Environmental Protection Agency for approval.

2. WATER QUALITY CONDITIONS

This section reviews pesticide concentrations and toxicity data collected during the 1990s and also summarizes more recent monitoring results. This information supports an impairment assessment in Section 5, "Project Description."

TOXICITY IN URBAN CREEKS

Toxicity Data

Bay Area urban runoff management agencies test urban runoff and urban creek water samples for toxicity using U.S. Environmental Protection Agency toxicity test methods. The "Whole Effluent Toxicity" test for freshwater determines whether samples are toxic to laboratory test species. It requires the use of three representative freshwater species: a zooplankton, typically *Ceriodaphnia dubia* (a tiny crustacean sometimes called a "water flea"); a phytoplankton, typically *Selenastrum capricornutum* (a single-celled green algae); and a fish, typically *Pimephales promelas* (the fathead minnow) (USEPA 2002g,h). In accordance with protocols, the responses of these laboratory test organisms are monitored and compared to those of control organisms. Assessing toxicity in this manner is consistent with the Basin Plan.

In the 1990s, tests revealed *Ceriodaphnia dubia* to be the most sensitive of the three test species when subjected to urban runoff (BASMAA 1996). As shown in Figure 2.1, of 125 samples collected primarily from Alameda County and Santa Clara County urban creeks, 74% resulted in 50% or greater *Ceriodaphnia dubia* mortality within 7 days. Samples from residential and commercial storm drains were also toxic to *Ceriodaphnia dubia*. Of 14 samples, 93% resulted in 50% or greater *Ceriodaphnia dubia* mortality within 7 days. The Bay Area data were similar to data collected in other urban regions, including elsewhere in Northern California (i.e., Sacramento and Stockton) (Bailey et al. 2000).

Ceriodaphnia dubia can be considered a surrogate for important creek organisms at the bottom of the food web. Although toxicity tests do not attempt to replicate creek conditions, *Ceriodaphnia dubia* toxicity is believed to reliably predict or understate biological community responses (USEPA 1991a; USEPA 1999). A U.S. Environmental Protection Agency study concluded that when toxicity is present in surface water, as determined through standard toxicity test methods, ecological impact is also likely, as indicated in Figure 2.2 (USEPA 1999).

The results of recent monitoring efforts suggest that toxicity occurs in urban creeks less frequently than in prior years. Data collected through the Surface Water Ambient Monitoring Program represent a number of urban and non-urban Bay Area creeks, listed in Table 2.1. Over 80 unique water samples were collected between September 2001 and June 2003 during the wet, spring, and dry seasons. As shown in Table 2.2, instances of *Ceriodaphnia dubia* toxicity were relatively infrequent (SFBRWQCB 2005d).

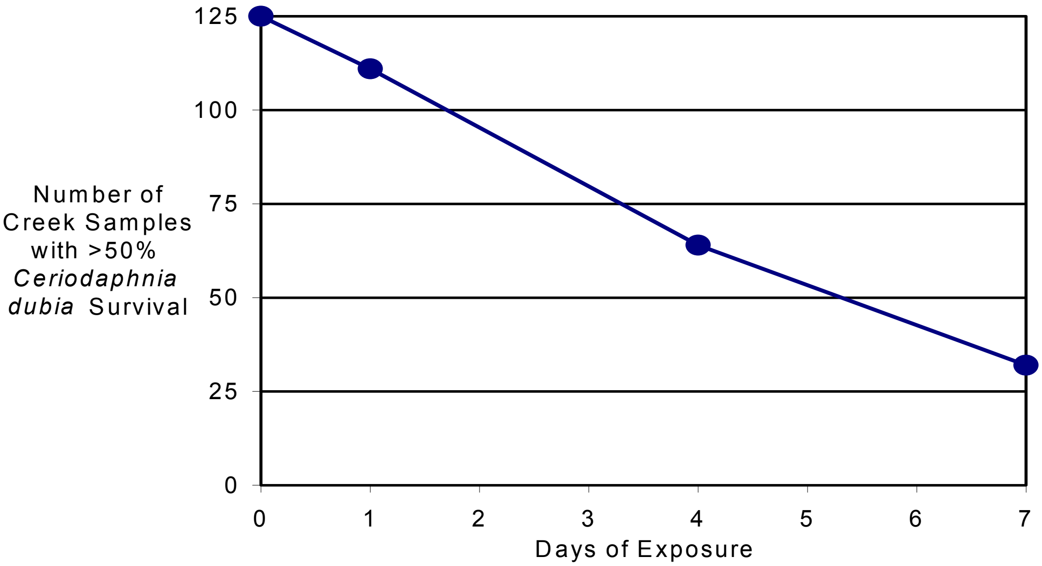


FIGURE 2.1
***Ceriodaphnia dubia* Survival in Bay Area Urban Creeks, 1989-1994**

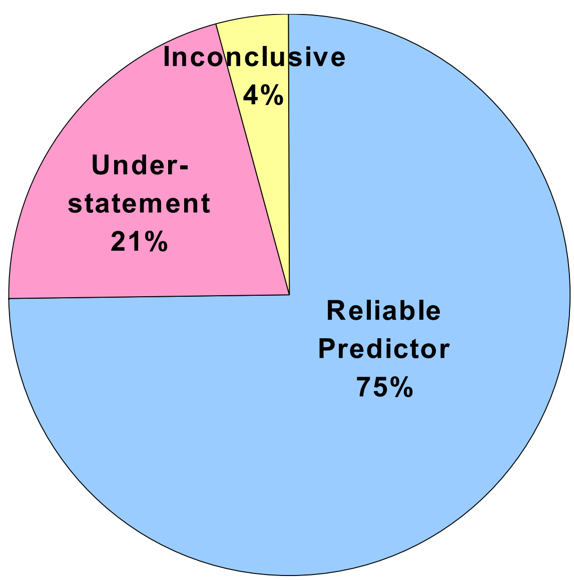


FIGURE 2.2
Reliability of Toxicity Tests in Predicting Biological Community Responses

In addition to these data, during 2002 and 2003, the Santa Clara Valley Urban Runoff Pollution Prevention Program collected eight Berryessa Creek, Penitencia Creek, and Silver Creek water samples during dry and wet weather, but no *Ceriodaphnia dubia* toxicity was observed (SCVURPPP 2003). In 2003 and 2004, the Santa Clara Valley

TABLE 2.1
Bay Area Creeks Sampled Through Surface Water Ambient Monitoring Program

Altamont Creek	Mitchell Canyon Creek	San Leandro Creek
Arroyo de las Positas	Mount Diablo Creek	San Mateo Creek
Butano Creek	Olema Creek	San Pablo Creek
Kaiser Creek	Permanente Creek	Stevens Creek
Kirker Creek	Polhemus Creek	Suisun Creek
La Honda Creek	San Antonio Creek	Wildcat Creek
Lagunitas Creek	San Geronimo Creek	Wooden Valley Creek
Lauterwasser Creek	San Gregorio Creek	

Source: SFBRWQCB 2005d.

TABLE 2.2
Bay Area Creek Toxicity, 2001-2003 [a]

	Urban Locations	Non-Urban Locations
Number of Samples [b]	40	42
Number of Samples with *Ceriodaphnia dubia* Toxicity:	2	2
When Diazinon Concentration >100 ng/l [c]	1	0
When Diazinon Concentration <100 ng/l [d]	1	2

ng/l, nanograms per liter
[a] For purposes of this table, "toxicity" refers to acute toxicity (mortality). The Surface Water Ambient Monitoring Program collected these data from September 2001 through June 2003.
[b] Most toxicity tests were completed using the same samples used for ELISA tests, and a few additional toxicity tests were completed (see Table 2.5).
[c] A diazinon concentration target of 100 ng/l is proposed in Section 7, "Numeric Targets." Water containing only diazinon (not a mixture of toxic substances) can exceed 100 ng/l diazinon without exceeding the toxicity targets.
[d] Because the two-day LC_{50} for diazinon is about 400 ng/l (USEPA 2000e), when acutely toxic samples contain diazinon concentrations below 100 ng/l, the toxicity is likely caused by some other chemical.
Source: SFBRWQCB 2005d.

Urban Runoff Pollution Prevention Program collected eight samples from Adobe Creek, San Tomas Creek, and Saratoga Creek during dry and wet weather. No acute *Ceriodaphnia dubia* toxicity was observed, but some inhibition of *Ceriodaphnia dubia* reproduction was observed in each creek, particularly during wet weather (SCVURPPP 2005).

The Clean Estuary Partnership funded toxicity monitoring in Blue Rock Springs Creek, Corte Madera Creek, Calabazas Creek, Castro Valley Creek, Rheem Creek, San Francisquito Creek, and San Pablo Creek during the months from January through April 2005. One of nine water samples (a Castro Valley Creek sample) was acutely toxic to *Ceriodaphnia dubia*, and three samples (from Castro Valley Creek, San Francisquito Creek, and Rheem Creek) reduced *Ceriodaphnia dubia* reproduction (CEP 2005a,c,e,g).

Cause of Toxicity

To ascertain the cause of the urban creeks' toxicity in the 1990s, Toxicity Identification Evaluations were undertaken in accordance with U.S. Environmental Protection Agency protocols. A Toxicity Identification Evaluation is a process used to identify the chemical or chemicals causing toxicity. In 1993 and 1994, toxic samples collected in Alameda County were subjected to Toxicity Identification Evaluations using *Ceriodaphnia dubia*. One study involved sampling San Lorenzo Creek and, to a lesser extent, Alameda Creek. Piperonyl butoxide, which inhibits the toxicity of organophosphorus pesticides, was added to test samples. Because the piperonyl butoxide decreased the toxicity of the samples, the chemical cause of the toxicity was suspected to be an organophosphorus pesticide.

Diazinon was detected in the samples at concentrations ranging from about 820 nanograms per liter (ng/l, parts per trillion) to 2,900 ng/l. These diazinon levels exceed the concentration lethal to 50% of *Ceriodaphnia dubia* within 2 days of exposure (the 2-day LC_{50}), which is about 400 ng/l (USEPA 2000e). Since diazinon was the primary pesticide in the samples and was present at potentially toxic levels, diazinon was concluded to be the organophosphorus pesticide responsible for the toxicity in San Lorenzo Creek and Alameda Creek (ACURCWP 1995a).

A similar study was conducted on water samples collected from Crandall Creek following a 1994 storm. Again, the Toxicity Identification Evaluation pointed to diazinon as the source of toxicity (ACURCWP 1995b).

In the 1990s, Toxicity Identification Evaluations completed elsewhere in California (i.e., Sacramento and Stockton) also found that organophosphorus pesticides caused toxicity in urban creeks (Bailey et al. 2000). Diazinon-related toxicity appeared to be common in urban areas.

In recent years, Toxicity Identification Evaluations have not been attempted in the relatively few instances when toxicity has been observed. At the concentrations the Clean Estuary Partnership measured recently (see below), diazinon is not known to affect *Ceriodaphnia dubia* survival or reproduction.

DIAZINON CONCENTRATIONS IN URBAN CREEKS

To date, most chemical monitoring has focused on diazinon. In the 1990s, in light of the evidence that diazinon caused toxicity in some Bay Area urban creeks, diazinon concentrations were measured in a larger number of Bay Area creeks. Following 1994 and 1995 winter storms, more than 175 water samples were collected from Bay Area urban creeks. Diazinon concentrations ranged from less than 30 ng/l (the detection limit) to about 700 ng/l. Table 2.3 lists some of the diazinon concentration data collected during the 1994-1995 rainy season (SWRCB et al. 1997). Relatively high diazinon concentrations could be found throughout the Bay Area. These preliminary measurements generated more detailed studies.

A study of Castro Valley Creek during the 1995-1996 rainy season measured diazinon concentrations following 12 storms. The Castro Valley Creek watershed is reasonably representative of Bay Area urban land use patterns. The area is predominantly low-density residential neighborhoods (50%), with some open space (35%) and commercial

TABLE 2.3
Selected Bay Area Creek Diazinon Concentrations, 1994-1995 Wet Season

Creek	Concentration (ng/l)
Crandall Creek	400
Rheem Creek	590
Walnut Creek	570
Codornices Creek	248
Dimond Creek	38
Castro Valley Creek	533
Strawberry Creek	162
Bockman Creek	397
San Pedro Creek	*
Adobe Creek	391
Barron Creek	165
Matadero Creek	130
San Francisquito Creek	74
Corte Madera Creek	*
Ignacio Creek	44
Belmont Creek	580
Calabazas Creek	343
Guadalupe Creek	143
Coyote Creek (Santa Clara County)	97
Napa River	*

ng/l, nanograms per liter
* The concentration was below the detection limit of 30 ng/l.
Source: SWRCB et al. 1997.

development (15%) (ACCWP and ACFCWCD 1997; SFBRWQCB 2004a). The watershed covers 5.5 square miles and is a sub-watershed of the San Lorenzo Creek drainage located in west central Alameda County (Chen et al. undated).

In this study, diazinon was detected in all Castro Valley Creek samples, and as shown in Figure 2.3, the mean concentration for each storm event ranged from a minimum of 180 to a maximum of 820 ng/l. The median concentration for all storm events was 310 ng/l. In some cases, values over 150 ng/l persisted for up to one week. The same study reported diazinon concentrations during periods of non-storm flows (during spring, when flows were less than 5 cubic feet per second) ranging from a low of 110 to a high of 760 ng/l, with a median of 420 ng/l. Samples collected during longer dry weather periods ranged from 35 to 220 ng/l, with a median of 80 ng/l (ACCWP and ACFCWCD 1997).

During the 1995 and 1996 dry seasons, diazinon was detected in all of 12 water samples collected from Castro Valley Creek. Concentrations ranged from 40 to 340 ng/l, with a median value of about 65 ng/l. Diazinon was detected in 16 of 18 water samples collected from Crandall Creek. The detection limit was 30 ng/l, and detected concentrations ranged from 58 to 442 ng/l. The median value was about 220 ng/l. Diazinon was detected in 8 of 9 samples collected at three inlets to Tule Pond in Fremont. The detection limit was 25 ng/l, and detected concentrations ranged from 80 to 3,000 ng/l. The median value was 300 ng/l (SWRCB et al. 1997).

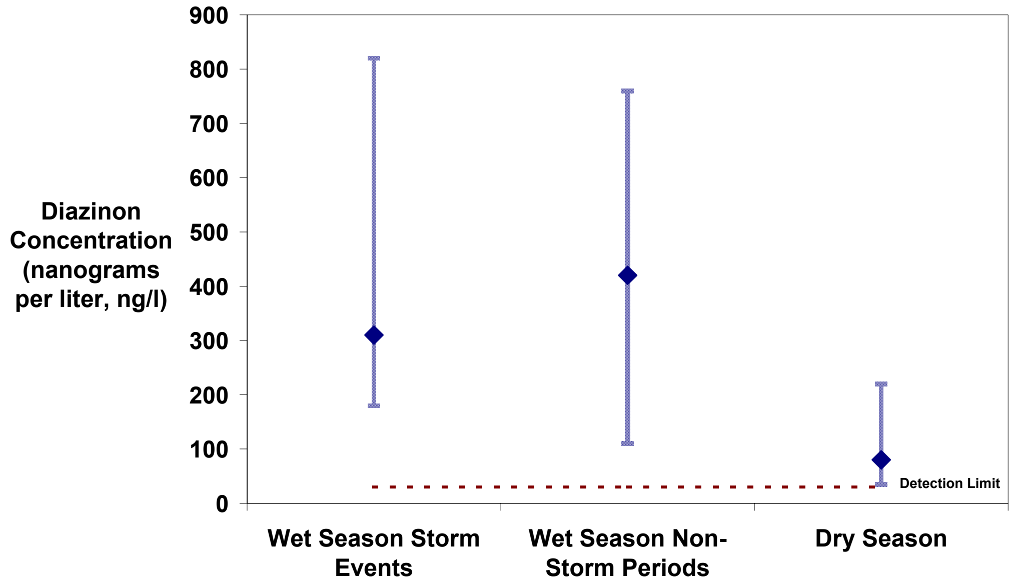


FIGURE 2.3
Diazinon Concentrations in Castro Valley Creek, 1995-1996

A study of 15 urban creeks throughout Alameda County involved collecting samples during the 1998 dry season. The samples were collected on Sunday afternoons, when gardening activity and pesticide applications were expected to be high. As shown in Table 2.4, diazinon was detected in 26 (44%) of 59 samples. The detection limit was 30 ng/l (ACCWP 1999a).

The diazinon concentrations in Bay Area urban creeks mirrored those in Sacramento and Stockton (Bailey et al. 2000).

The results of more recent Surface Water Ambient Monitoring Program monitoring efforts suggest that diazinon occurs in urban creeks less frequently and at lower concentrations than in prior years (SFBRWQCB 2005d). Between September 2001 and June 2003, water samples were collected from the creeks listed in Table 2.1 during the wet, spring, and dry seasons. Two analytical techniques were used to measure diazinon concentrations: gas chromatography/mass spectrometry (GC/MS), with a detection limit of 5 ng/l, and enzyme-linked immunosorbent assay (ELISA), with a detection limit of 30 ng/l. As shown in Table 2.5, diazinon was more often detected in urban creeks than non-urban creeks, and the range of detected concentrations included higher concentrations in urban creeks. More often than not, the diazinon concentrations could not account for observed toxicity (refer to Table 2.2).

In addition to these data, the Clean Estuary Partnership funded diazinon monitoring in Blue Rock Springs Creek, Corte Madera Creek, Calabazas Creek, Castro Valley Creek, Rheem Creek, San Francisquito Creek, and San Pablo Creek during the months from January through April 2005. Diazinon was detected in five of the nine samples (the

TABLE 2.4
Diazinon in Alameda County Creeks, 1998 Dry Season

Urban Creek	Number of Samples	Number of Detections*	Range of Detected Concentrations (ng/l)	Median Detected Concentration (ng/l)
Cerrito Creek	8	2	57 - 241	150
Codornices	2	0		
Strawberry Creek	2	0		
Glen Echo Creek	5	3	32 - 92	92
Sausal Creek	2	0		
Arroyo Viejo	2	0		
San Leandro Creek	5	0		
Castro Valley Creek	5	5	32 - 149	42
San Lorenzo Creek	1	1	37	37
Ward Creek	2	1	29	29
Alameda Creek	5	1	137	137
Arroyo de la Laguna	10	7	57 - 617	94
Agua Caliente	2	1	33	33
Agua Frio	2	1	82	82
Scott Creek	5	3	55 - 251	73

* Detection limit = 30 ng/l
ng/l, nanograms per liter
Source: ACCWP 1999a.

TABLE 2.5
Bay Area Creek Diazinon Concentrations, 2001-2003 [a]

	Urban Locations		Non-Urban Locations	
	GC/MS[b]	ELISA[c]	GC/MS[b]	ELISA[c]
Number of Samples	30	35	34	38
Number of Sample Locations	13	16	16	17
Number of Diazinon Detections [d]	23	13	7	1
Range of Detected Concentrations (ng/l)	10 - 501	35 - 741	13 - 34	37
Median Detected Concentration (ng/l)	25	57	13	37
Number of Samples Above Diazinon Concentration of 100 ng/l [e]	3	3	0	0
Number of Samples Above Diazinon Concentration of 100 ng/l [e] with **No** *Ceriodaphnia dubia* Toxicity [f]	NA	2	NA	0

ng/l, nanograms per liter
NA, not available
[a] The Surface Water Ambient Monitoring Program collected these data from September 2001 through June 2003. Many GC/MS and ELISA samples were collected at the same time, but tests were not completed on the same samples.
[b] GC/MS, Gas Chromatography / Mass Spectrometry analytical method. Toxicity tests were not conducted on these samples.
[c] ELISA, Enzyme-Linked ImmunoSorbent Assay analytical method. Toxicity tests were conducted on these samples.
[d] GC/MS Detection limit = 5 ng/l; ELISA Detection limit = 30 ng/l.
[e] A diazinon concentration target of 100 ng/l is proposed in Section 7, "Numeric Targets."
[f] Diazinon concentrations may exceed 100 ng/l without causing *Ceriodapnia dubia* toxicity (the 2-day LC_{50} is about 400 ng/l).
Source: SFBRWQCB 2005d.

detection limit was 5 ng/l). The concentration ranged from 41 to 51 ng/l in four samples and was 117 ng/l in a Castro Valley Creek sample (CEP 2005b,d,f,h).

The Santa Clara Valley Urban Runoff Pollution Prevention Program collected seven samples from Santa Clara County creeks (Berryessa Creek, Penitencia Creek, Silver Creek, and Thompson Creek) during September 2002 (dry weather) (SCVURPPP 2003). None contained diazinon concentrations above the reporting limit of 10 ng/l, except for one sample from Berryessa Creek, which contained 20 ng/l diazinon. Of seven samples collected from the same creeks during January 2003 (wet weather), one from Penitencia Creek and one from Silver Creek contained diazinon concentrations above the reporting limit of 10 ng/l. Their diazinon concentrations were 20 ng/l and 30 ng/l. During April 2003, as wet weather subsided, one sample out of seven collected from these creeks contained diazinon above the reporting limit of 10 ng/l. That Berryessa Creek sample contained 50 ng/l diazinon. In September 2003 and January 2004, the Santa Clara Valley Urban Runoff Pollution Prevention Program collected eight samples from Adobe Creek, San Tomas Creek, and Saratoga Creek (SCVURPPP 2005). None contained diazinon concentrations above the reporting limit of 30 ng/l.

The Alameda Countywide Clean Water Program collected two Castro Valley Creek samples during the 2002/2003 rainy season and one Castro Valley Creek sample during the 2003/2004 rainy season. No diazinon was detected, but the detection limits were relatively high at 200 ng/l and 50 ng/l (ACCWP 2003). During the 2004/2005 rainy season, the Alameda Countywide Clean Water Program used lower detection limits and found 46 and 51 ng/l diazinon in two Castro Valley Creek samples (ACCWP 2005).

The U.S. Environmental Protection Agency analyzed five Napa River samples and five Sonoma Creek samples collected in October 2002. (One of the Sonoma Creek samples came from Sugarloaf State Park, a rural area). All the samples contained less than 50 ng/l diazinon (USEPA 2002b).

KEY POINTS

- In the early 1990s, many Bay Area urban creek water samples were toxic to *Ceriodaphnia dubia* test organisms.
- *Ceriodaphnia dubia* toxicity reliably predicts or understates biological community responses.
- Toxicity Identification Evaluations using *Ceriodaphnia dubia* concluded that diazinon caused the toxicity.
- Diazinon concentrations high enough to account for aquatic toxicity were widespread in urban creeks.
- In recent years, diazinon and toxicity occur less frequently than in prior years, but they still occur.

3. PESTICIDE USE TRENDS

This section summarizes pesticide use trends for the nine Bay Area counties and supports the impairment assessment in Section 5, "Project Description." As discussed in Section 2, "Water Quality Conditions," diazinon has been linked to aquatic toxicity in urban creeks and most creek monitoring has focused on diazinon. Therefore, this section focuses first on diazinon use trends and then reviews trends for other pesticides, which, for reasons explained below, may be replacing diazinon in the urban marketplace.

Much of the information summarized below is from the California Department of Pesticide Regulation's Pesticide Use Reporting database. California requires all agricultural pesticide applications to be reported to County Agricultural Commissioners. The California Department of Pesticide Regulation compiles these data. (For reporting purposes, the term "agriculture" is defined to include parklands, golf courses, rights of way, rangelands, pastures, and cemeteries [i.e., anything but residential, industrial, and institutional sites], as well as conventional agriculture.) Commercial pest control professionals that apply pesticides for structural pest control and landscape maintenance must also report their pesticide applications. (The term "structural pest control" refers to the control of household pests and wood destroying pests, or other pests that may invade households or other structures. The term "landscape maintenance" refers to pest control in natural or planted ornamental or turf areas, such as around residences, other buildings, golf courses, parks, school grounds, or cemeteries.) In contrast, private citizens are not required to report their use of products purchased over-the-counter and applied at their private homes and gardens.

The data discussed below refer to "active" pesticide product ingredients. The many so-called "inert" ingredients that make up product formulations are not included when discussing quantities.

DIAZINON APPLICATIONS

Reported Use

Diazinon is a broad-spectrum organophosphorus pesticide used to control a variety of pests. Diazinon application data reported for the nine Bay Area counties can be used to estimate diazinon applications within the Water Board's jurisdiction. The difference between the county boundaries used for pesticide reporting and the Water Board boundaries (which, as shown in Figure 3.1, are based essentially on watershed drainage areas) introduces some inexactness. Many of the nine Bay Area counties straddle the Water Board boundaries, so a portion of the reported diazinon for those counties is applied outside the Water Board's jurisdiction. Areas outside the Water Board's jurisdiction tend to be rural, and areas within the Water Board's jurisdiction tend to be urban. Therefore, when using county data to estimate reported diazinon applications within the Water Board's jurisdiction, the pesticide use reported for structural pest control and landscape maintenance (primarily urban uses) may be slightly overstated.

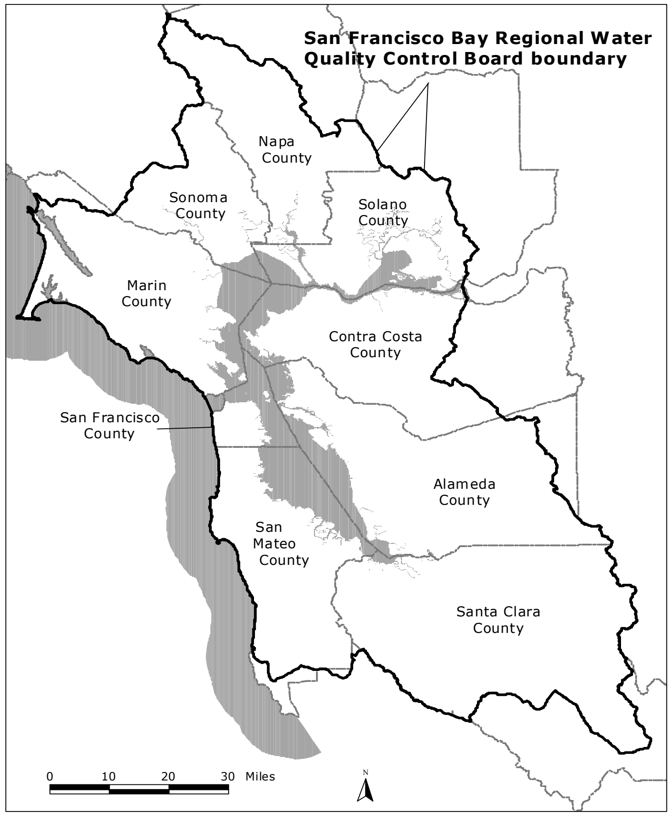


FIGURE 3.1
Water Board Jurisdiction Boundaries and the Nine Bay Area Counties

The pesticide use reported for agriculture (primarily a rural use) is likely substantially overstated. For example, California Department of Pesticide Regulation data for 2000 showed that 1,960 pounds of diazinon were applied for agricultural purposes within the Water Board's jurisdiction (CDPR 2004). This represented less than 15% of the 13,472 pounds of diazinon applied for agricultural purposes throughout the nine Bay Area counties. The amount of diazinon applied for agricultural purposes within the Water Board's jurisdiction was also very small (roughly 3%) compared to the total amount of diazinon use reported in 2000 for the Bay Area counties (CDPR 2001a).

Figure 3.2 shows diazinon applications from 1995 through 2003 (CDPR 2005; CDPR 2003a; CDPR 2002a; CDPR 2001a; CDPR 2000a,b; CDPR 1999a,b; CDPR 1996). Until 1999, applications were generally stable, with relatively minor fluctuations probably due to differences in weather or specific pest problems. During this period, an annual average of about 90,000 pounds of diazinon were applied and reported. More diazinon use was reported in Santa Clara County than in any other Bay Area county. Contra Costa County ranked second. About 54% of the total diazinon applied and reported was associated with structural pest control, about 28% was associated with agriculture, about 18% was associated with landscape maintenance, and less than 1% was associated with other types of applications. As explained above, agricultural applications occurred primarily outside the Water Board's jurisdiction.

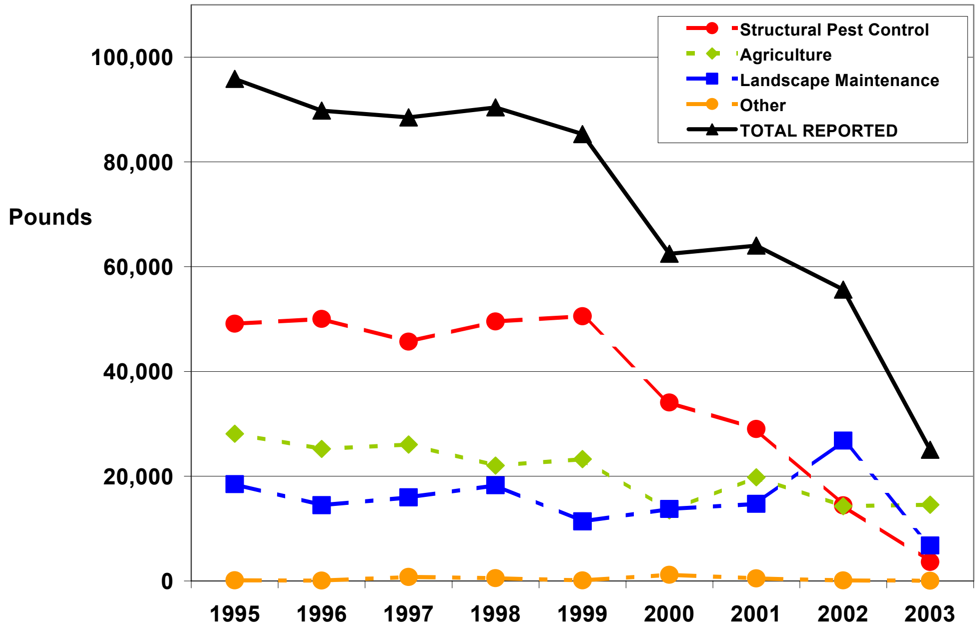


FIGURE 3.2
Reported Bay Area Diazinon Applications, 1995-2003

Unreported Use

In the 1990s, substantial urban diazinon use was unreported. The City of Palo Alto estimated that, in urban areas, unreported diazinon applications accounted for up to 60% of all diazinon use, with as little as 40% of urban diazinon use being reported (Palo Alto 1996). On the basis of estimated sales in Castro Valley and reported applications there, Alameda County estimated that reported and unreported applications each accounted for about 50% of all diazinon use (ACFCWCD 1997). Assuming that unreported use was 50% of all use, total diazinon use in the 1990s was about 180,000 pounds or 90 tons per year.

CHANGING TRENDS

Figure 3.2 shows that, beginning in 2000, diazinon use began to change substantially. The trend reflects the recent phase-out of most urban diazinon uses and the growing use of diazinon alternatives.

Diazinon Phase-Out

The Food Quality Protection Act enacted in 1996 required the U.S. Environmental Protection Agency to reassess the risks associated with many pesticides, including diazinon. The law increased safety standards for pesticides and focused special attention on children's health. To comply with the law, the U.S. Environmental Protection Agency undertook a new risk assessment for diazinon, focusing its attention on human health. The study found that all residential applications result in exposures that posed risks of concern. Following applications in residential areas, diazinon residues posed risks of concern for children. Many types of occupational exposures also posed risks of concern, and exposure to diazinon in drinking water could have potentially posed a concern for infants and children (USEPA 2000b).

The study concluded the following regarding environmental risks (USEPA 2000f):

> *Because of diazinon's widespread use in the U.S., and documented widespread presence in water bodies at concentrations of concern to aquatic life, there is a high level of certainty that aquatic organisms will be exposed to potentially toxic levels of diazinon in surface water. Additionally, since diazinon and its major degradate oxypyrimidine are mobile and persistent in the environment, and found at significant levels in both ground and surface waters, it is quite probable that they will be available in quantity and for times that will exceed acute and chronic toxicity endpoints.*

As the U.S. Environmental Protection Agency released its study, Syngenta Crop Protection, the lead registrant for diazinon at the time, announced that it would phase out its residential end use diazinon products (Syngenta 2000; USEPA 2000c). The U.S. Environmental Protection Agency has since phased out many diazinon products consistent with Syngenta Crop Protection's announcement. It phased out indoor uses first, followed by non-agricultural outdoor uses (e.g., home lawns, gardens, and other residential and non-agricultural uses). Retail sales ended December 31, 2004. Diazinon use is now limited to agricultural crops. Diazinon continues to be allowed at nurseries (i.e., ornamental plants grown outdoors) and for cut flowers (nurseries and fields only, not greenhouses) (TDC 2002; USEPA 2002a).

Diazinon Alternatives

Diazinon has long been one of the most commonly used pesticides on the market. Although the U.S. Environmental Protection Agency's actions eliminated most urban diazinon uses, phasing out diazinon increased reliance on alternative pesticides and encouraged new pesticides to enter the marketplace. Replacement pesticides are increasing their market share by fulfilling the perceived needs of pesticide consumers. Section 10, "Proposed Implementation Actions," briefly describes pest management alternatives that rely less heavily on pesticides that could affect water quality. However, given the likelihood that consumers will look to more conventional chemical alternatives instead of less toxic options (which often require additional knowledge and behavior modifications), the remainder of this section focuses on the water quality implications of the increasing use of the most likely pesticide alternatives to diazinon.

The Water Board commissioned a study, *Insecticide Market Trends and Potential Water Quality Implications*, to evaluate pesticide use trends as they relate to water quality. In 2003, on the basis of current and projected pesticide use and possible water quality risks, the report considered the pesticide alternatives of potential concern for water quality to be bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, permethrin, carbaryl, malathion, imidacloprid, and pyrethrins (SFBRWQCB 2003a). A more recent study also identified lambda cyhalothrin and fipronil among pesticides of interest (SFEP 2005a). Table 3.1 provides some basic information about these pesticides.

Reported Use. On the basis of California Department of Pesticide Regulation data, Figures 3.3 through 3.5 present recent trends (1999 through 2003) in reported use of the pesticides listed above for the nine Bay Area counties. This period matches the years during which reported diazinon applications, shown in Figure 3.2, decreased. Only structural pest control and landscape maintenance applications are included in Figures 3.3 through 3.5 because these uses are most closely associated with the urban diazinon uses the U.S. Environmental Protection Agency phased out. The total applications shown in Figures 3.3 through 3.5 refer to the sum of the structural pest control and landscape maintenance applications, not total overall use (SFBRWQCB 2004c; SFBRWQCB 2005h; CDPR 2005).

As shown in Figures 3.3 through 3.5, reported pesticide applications vary substantially from year to year. In many instances, overall trends are unclear. The variations may relate to year-to-year weather differences, changes in pest problems, or inconsistent reporting. They may also relate to economic factors. When the economy is sluggish, some people may not hire pest control professionals who report their applications. Instead, they may opt to apply over-the-counter pesticides or postpone treatment.

TABLE 3.1
Likely Diazinon Alternatives

Chemical Class	Chemical	Notes
Pyrethrins	Pyrethrins	Naturally occurring chemicals in pyrethrum, a powder made from chrysanthemums. Interfere with nerve function. Relatively short half-life.
Pyrethroids	Bifenthrin Cyfluthrin Cypermethrin Deltamethrin Esfenvalerate Lambda cyhalothrin Permethrin	Synthetic chemicals similar to but generally more toxic than naturally occurring pyrethrins. Share similar mode of toxicity. Like pyrethrins, interfere with nerve function. Relatively long half-lives compared to pyrethrins. Generally exhibit low water solubility, low volatility, and high particle affinity. Relatively immobile in soil. Strongly bind to sediment.
Carbamates	Carbaryl	Synthetic analog of chemicals in West African calabar bean extract. Like diazinon, interferes with nerve function by inhibiting acetylcholinesterase.
Organophosphates	Malathion	Chemically similar to diazinon. Like diazinon, inhibits acetylcholinesterase.
Phenylpyrazoles	Fipronil	Interferes with nerve function by blocking chloride channels of nerve cells.
Nicotinoids	Imidacloprid	Chemically similar to nicotine, a natural insecticide in tobacco. Interferes with nerve function. Relatively low human toxicity, but high water solubility.

Source: SFBRWQCB 2003a; NPTN 1997

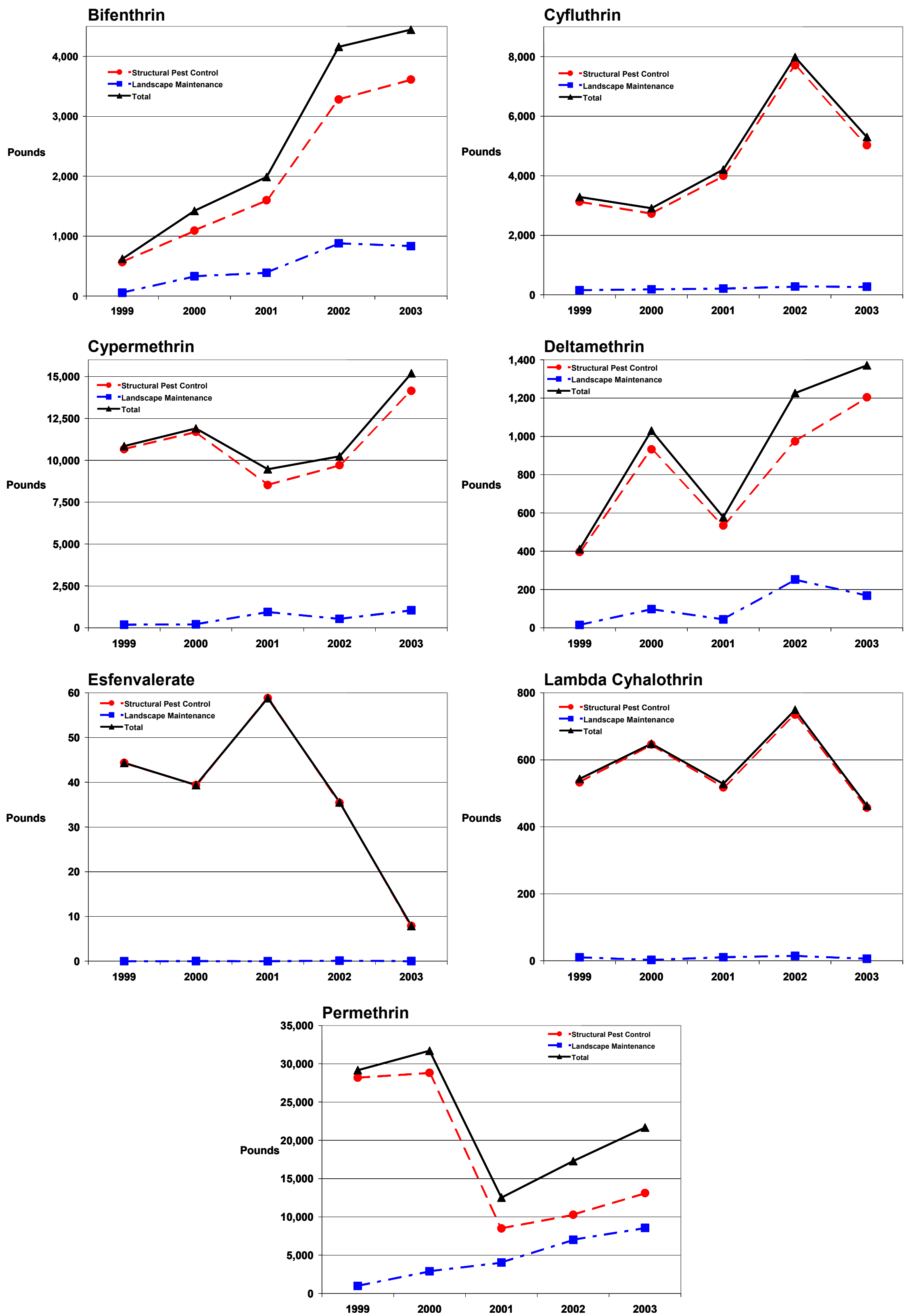


FIGURE 3.3
Reported Bay Area Pyrethroid Application Trends

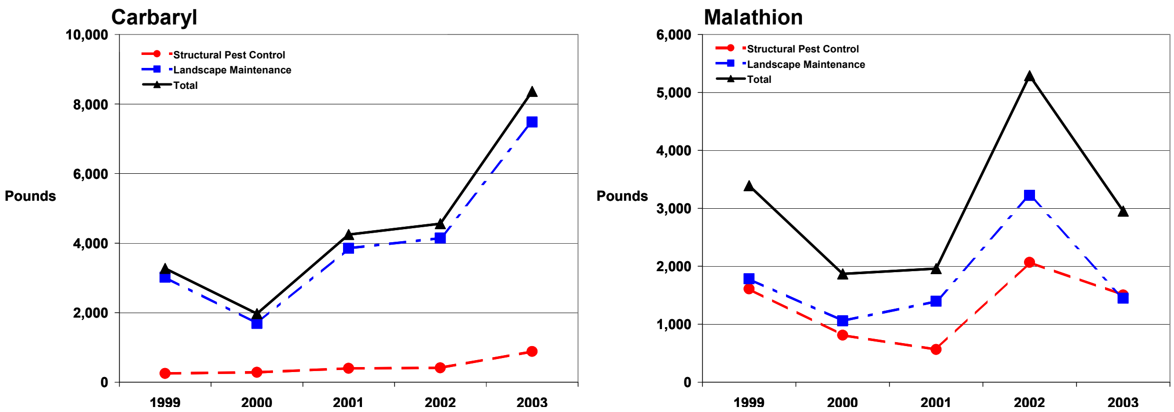


FIGURE 3.4
Reported Bay Area Carbaryl and Malathion Application Trends

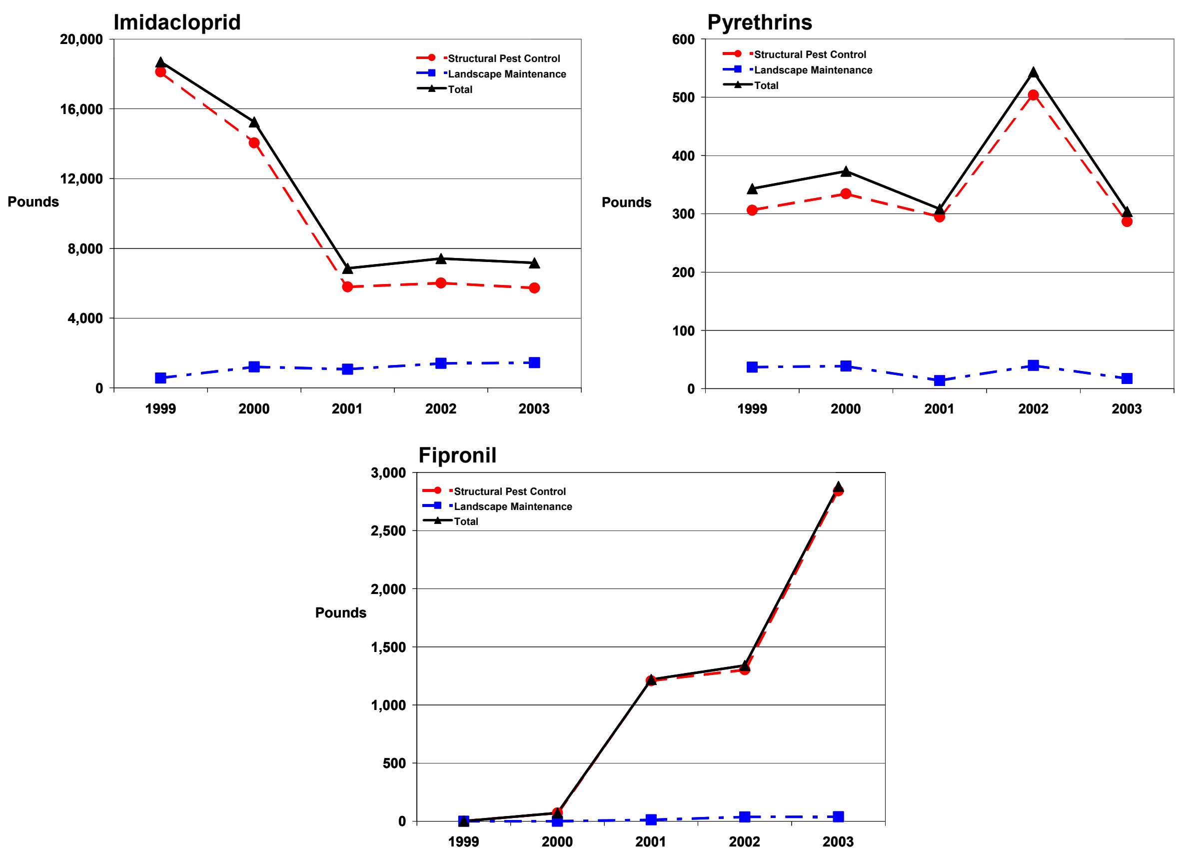


FIGURE 3.5
Reported Bay Area Imidacloprid, Pyrethrins, and Fipronil Application Trends

Figure 3.3 shows trends in reported pyrethroid use. Reported pyrethroid applications are generally greater for structural pest control than for landscape maintenance. Total reported use of some pyrethroids (e.g., bifenthrin, cyfluthrin, cypermethrin, and deltamethrin) appears to be rising. Trends for others (e.g., lambda cyhalomethrin and permethrin) are unclear. Reported esfenvalerate use is clearly declining. In some cases, such as with permethrin, trends in outdoor use are confounded because the reported data represent substantial indoor and underground treatments in addition to outdoor applications. Landscape maintenance use of bifenthrin, cypermethrin, deltamethrin, and permethrin is increasing.

As shown in Figure 3.4, relatively greater quantities of carbaryl and malathion are used for landscape maintenance compared to structural pest control (in contrast to the pyrethroids). Carbaryl use for landscape maintenance is increasing. Figure 3.5 shows that, while imidacloprid applications for structural pest control may be dropping, landscape applications may be rising. Fipronil use for structural pest control rose sharply from 2000 to 2003.

The data in Figures 3.3 through 3.5 should not be over-interpreted. The increasing and decreasing trends the figures suggest may not relate directly to water quality risks. While many foreseeable diazinon alternatives are manufactured with formulations similar to the diazinon products they are replacing, some may be formulated differently (e.g., as baits). Moreover, as mentioned above regarding permethrin, some of the reported replacement pesticides may be applied to sites that do not pose significant surface water quality concerns (e.g., underground injection). Section 6, "Source Assessment," discusses the effects of formulations and application sites on the potential for runoff. Since the amount of pesticide required for a particular application varies with formulation, application site, and relative toxicity, the vertical scales (pounds) used in Figures 3.3 through 3.5 differ for each pesticide and cannot be compared directly with one another.

Another factor confounding the interpretation in these trend data are that, while diazinon was a leader in the pesticide market, it is being replaced by numerous alternatives. The result is that changes in the use of any particular replacement are less pronounced than the changes in diazinon use. Nevertheless, since the mode of toxicity is the same for many alternatives (e.g., the pyrethroids), potential ecological risks relate to the combined use of all the replacements.

Unreported Use. Figures 3.3 through 3.5 do not include unreported pesticide applications, which in the 1990s represented 50% to 60% of diazinon use (Palo Alto 1996; ACFCWCD 1997). Unreported diazinon use has essentially been phased out, and over-the-counter consumers are looking for alternatives. According to a recent shelf survey of Bay Area retail stores, pyrethroids are overtaking the over-the-counter marketplace. Most retail insecticides contain pyrethroids. The most common pyrethroid in retail stores is permethrin, followed by cyfluthrin, esfenvalerate, and bifenthrin. Malathion, carbaryl, imidacloprid, and other possible diazinon replacements appear to be less common (USEPA 2003c; TDC 2004).

To estimate total Bay Area urban use requires an understanding of over-the-counter sales (unreported) and reported urban use (see Figures 3.3 through 3.5). Pesticides sales data are available on a statewide basis, and Bay Area sales can be estimated on the basis of the Bay Area's relative population compared to that of the entire state. This approach involves substantial uncertainties because pesticides sold in a particular year may not be applied in that year (or at all) and Bay Area residents may not use over-the-counter pesticides in the same proportions as residents elsewhere in California due to differences in climate and pest problems. Nevertheless, this is a reasonable approach for evaluating trends in urban pesticide use in the absence of region-specific information.

Figures 3.6 through 3.8 illustrate trends in urban use for several pesticides, including both over-the-counter use (unreported) and structural pest control and landscape maintenance use (reported) (SFEP 2005a; TDC 2005a). As shown in Figure 3.6, urban use of most pyrethroids appears to be increasing since 1999. Permethrin is the only exception. It has been increasing since 2001, however. The substantial growth in cyfluthrin use is due almost entirely to recent increases in over-the-counter use of one particular type of cyfluthrin, beta-cyfluthrin. As shown in Figure 3.8, urban pyrethrins use and fipronil use are also rising. Urban imidacloprid use is dropping. Trends in urban carbaryl and malathion use, shown in Figure 3.7, are unclear.

The pesticides sold and applied in the Bay Area relate to Bay Area pest problems. If new exotic pests enter the Bay Area, pesticide use trends could change significantly. The potential for new exotic pests (like the red imported fire ant) to enter the Bay Area is an ongoing concern. California Agricultural Commissioners and the California Department of Food and Agriculture work to intercept such pests before they become widespread. Unfortunately, in recent years, funding for these programs has sharply declined. The threats that new exotic pests pose include the possible need to apply pesticides to control them.

EMERGING WATER QUALITY CONCERNS

The water quality risks posed by a pesticide relate to the quantity of the pesticide used, its runoff characteristics, and its relative toxicity in water and sediment. As urban diazinon applications are phased out, the use of some alternatives may inadvertently pose new water quality risks. Given what is known about pesticide use trends, the pyrethroid alternatives may pose the greatest concerns for water quality.

In water, pyrethroids tend to be toxic at relatively low concentrations. The California Department of Fish and Game has developed acute (one-hour exposure) water quality criteria for two pyrethroids, cypermethrin (2 ng/l) and permethrin (30 ng/l) (CDFG 2000a). These concentrations are lower than the equivalent diazinon criterion, 160 ng/l (CDFG 2000b; CDFG 2004). Depending on the specific pyrethroid tested, concentrations ranging from 70 ng/l to 700 ng/l are toxic to *Ceriodaphnia dubia*. Concentrations within this range have been lethal to 50% of test organisms (Miller et al. 2002). These concentrations are comparable to the diazinon concentrations lethal to 50% of *Ceriodaphnia dubia* test organisms (about 400 ng/l) (SFBRWQCB 2003a; USEPA 2000e).

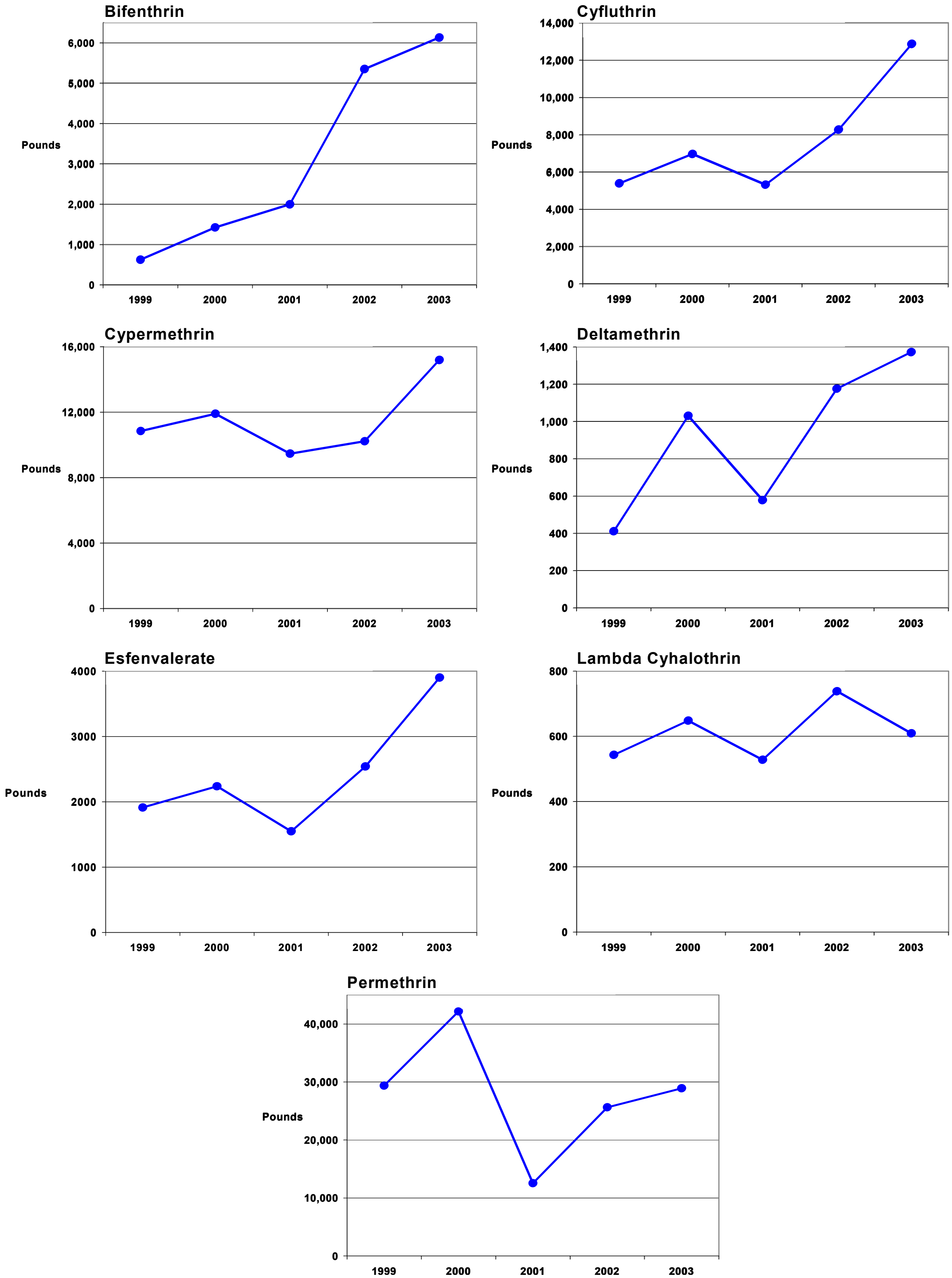


FIGURE 3.6
Urban Bay Area Pyrethroid Application Trends

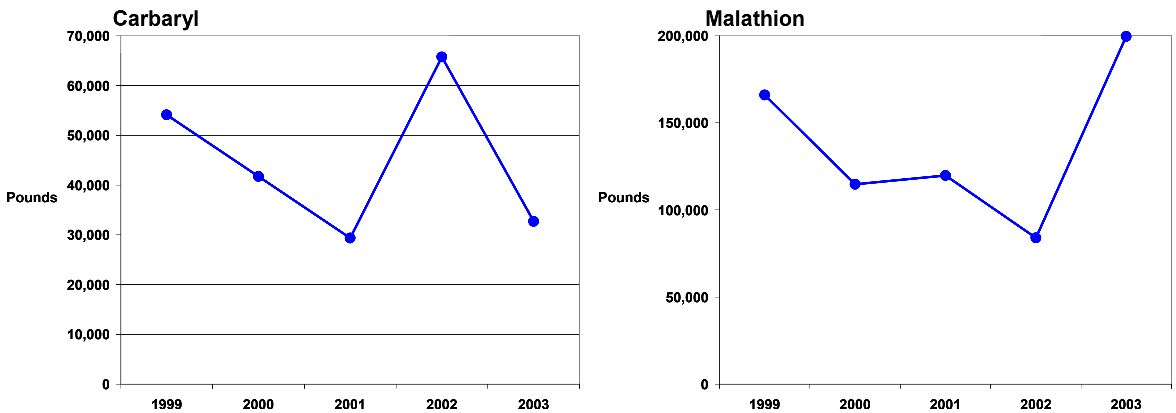


FIGURE 3.7
Urban Bay Area Carbaryl and Malathion Application Trends

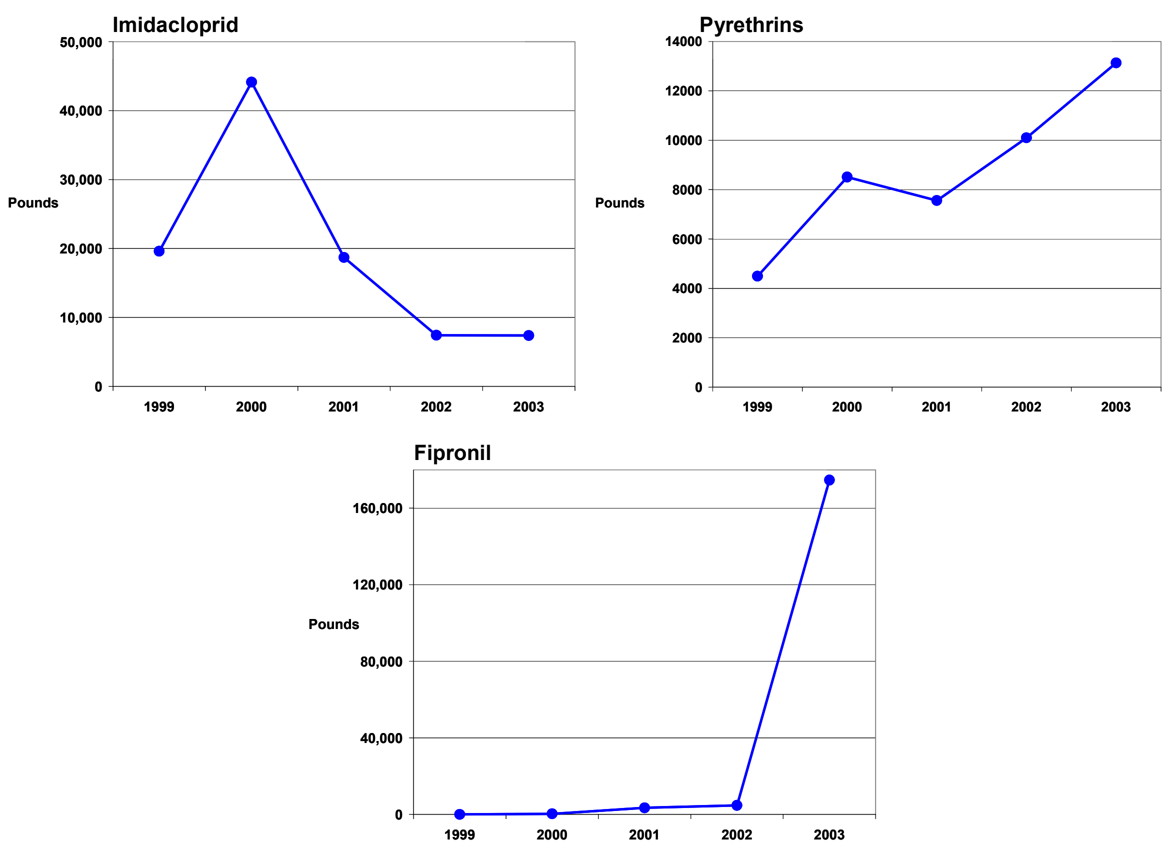


FIGURE 3.8
Urban Bay Area Imidacloprid, Pyrethrins, and Fipronil Application Trends

Some pyrethoids are toxic to invertebrates and fish at concentrations as low as 6 ng/l (Miller et al. 2002). At concentrations of 4 ng/l, cypermethrin inhibits the ability of male Atlantic salmon to smell a female pheromone. When salmon sperm and eggs are exposed at 100 ng/l, cypermethrin reduces the number of fertilized eggs (Moore and Waring 2001). Some pyrethroids have the potential to disrupt hormonal functions (Tyler et al. 2000). In daphnids, pyrethroid concentrations as low as 10 ng/l reduce reproduction and lower food filtration rates (Day 1989).

Pyrethroids do not dissolve well in water but adhere well to surfaces, including particles in the environment (see Section 8, "Linkage Analysis"). At equilibrium, pyrethroid concentrations in sediment are reported to be about 3,000 times greater than dissolved concentrations in water (Amweg et al. 2005b). In one study, the amount of permethrin bound to sediment was about 400 to 8,000 times greater than the amount of permethrin in an equal mass of water. Similarly, the amount of bifenthrin in sediment was about 500 to 20,000 times greater than the amount in an equal mass of water (Gan et al. 2005). (More of these pesticides bound to sediment as the organic carbon content of the sediment increased.) Therefore, particulate-bound pyrethroids may be more likely to cause toxicity than pyrethroids in the water column. Reports of pyrethroid toxicity in sediment are beginning to emerge.

In the agricultural arena, researchers investigating Central Valley sediment from irrigation canals and small creeks dominated by agricultural runoff found that 42% of the locations sampled exhibited significant mortality to a test species on at least one occasion. Two creeks and four irrigation channels (14% of the sites) showed more than 80% mortality on at least one occasion. Pyrethroids were detected in 75% of the samples, with permethrin being the most common, followed by esfenvalerate, bifenthrin, and lambda cyhalothrin. Pyrethroid concentrations were sufficiently high to have contributed to the toxicity in 40% of samples toxic to *Chironomus tentans* and nearly 70% of samples toxic to *Hyallela azteca* (Weston et al. 2004; Amweg et al. 2005a). *Chironomus tentans* and *Hyallela azteca* are sediment-dwelling invertebrates used in standard sediment toxicity tests. *Hyallela* sp. and *Chironomus* sp. are found in Bay Area urban creeks. These findings demonstrate that pyrethroids can runoff into creeks and can cause sediment toxicity there.

In the Bay Area, researchers have found several pyrethroids in sediment collected from several urban creeks (Amweg et al. 2005b). The sediment was often toxic to *Hyallela azteca*, and pyrethroids were often present at concentrations expected to cause toxicity to *Hyalella azteca*. Similar results have been found in some Sacramento area urban creeks. Details of these recent investigations are not yet published, but the work indicates the potential that pyrethroids may already cause sediment toxicity in at least some Bay Area urban creeks (Weston 2005). The potential presence of pyrethroids offers a plausible explanation for as yet unexplained *Hyalella azteca* mortality observed in three of four Surface Water Ambient Monitoring Program sediment samples collected in 2003 (SFBRWQCB 2005g).

KEY POINTS

- Until 1999, diazinon applications were generally stable, but beginning in 2000, they began to decline substantially.
- The U.S. Environmental Protection Agency phased out urban diazinon applications at the end of 2004.
- Phasing out diazinon increased the use of alternative pesticides and encouraged new pesticides to enter the marketplace.
- Some likely diazinon alternatives, particularly the pyrethroids, pose water quality concerns.
- Pyrethroids may already cause sediment toxicity in at least some Bay Area urban creeks.

4. REGULATORY OVERSIGHT

This section provides an overview of the primary agencies and organizations that oversee pesticide use and pesticide discharges to urban creeks, and summarizes gaps in how pesticide and water quality regulatory programs are implemented. This information supports the impairment assessment in Section 5, "Project Description."

As Figure 4.1 indicates, separate but related agencies oversee pesticides and water quality at the federal, state, and local level. The following agencies play the greatest roles:

- U.S. Environmental Protection Agency, including the Office of Pesticide Programs and the Office of Water;
- California Environmental Protection Agency, including the San Francisco Bay Regional Water Quality Control Board and State Water Resources Control Board (Water Boards), and the Department of Pesticide Regulation; and
- Local agencies, including urban runoff management agencies and County Agricultural Commissioners.

Other relevant government entities include the California Department of Consumer Affairs (i.e., the Structural Pest Control Board) and the University of California Statewide Integrated Pest Management Program.

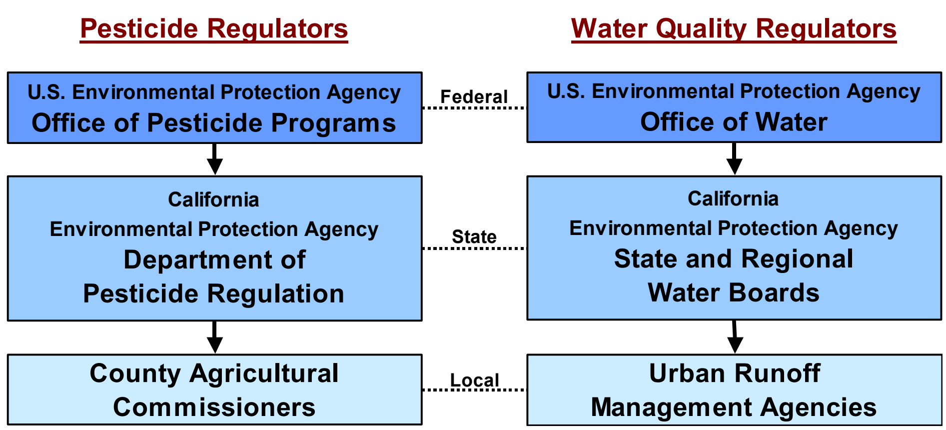


FIGURE 4.1
Primary Pesticide and Water Quality Oversight Agencies

U.S. ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency's Office of Water is responsible for implementing the Federal Clean Water Act, which is intended "to restore and maintain the chemical, physical, and biological integrity of the nation's waters" (Title 33, U.S. Code, §1251[a]). According to the Clean Water Act, "It is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited" (Title 33, U.S. Code, §1251[3]). The U.S. Environmental Protection Agency authorizes some states, including California, to administer many Clean Water Act programs. The Office of Water provides national leadership and guidance to states and oversees program administration. It develops nationwide water quality standards, assesses the quality of the nation's waters, and oversees TMDL development.

The U.S. Environmental Protection Agency's Office of Pesticide Programs is responsible for regulating pesticide manufacture and use under the Federal Insecticide, Fungicide, and Rodenticide Act. The agency can limit the distribution, sale, or use of a pesticide to the extent necessary to prevent unreasonable adverse effects on the environment. The Federal Insecticide, Fungicide, and Rodenticide Act defines the term "unreasonable adverse effects on the environment" to include "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide" (Title 7, U.S. Code, §136[bb] and §136a).

Pesticide manufacturers and formulators must register their products with the U.S. Environmental Protection Agency. To determine whether pesticides are eligible for registration, the agency examines environmental, health, and safety data and potential risks to individuals who could be exposed to the pesticide. To be eligible for registration, a pesticide must not cause unreasonable risks to human health or the environment when used in accordance with its label, which provides detailed instructions for its use. The label names active ingredients, specifies application instructions, provides warnings and first aid information, and describes appropriate storage and disposal procedures. Only the U.S. Environmental Protection Agency can approve pesticide label changes.

When the U.S. Environmental Protection Agency registers a pesticide, it evaluates the pesticide's environmental fate and ecological effects. This typically involves studying how the pesticide moves in surface water and groundwater following an application scenario, which is typically an agricultural scenario. The U.S. Environmental Protection Agency rarely considers typical urban application scenarios, such as applying pesticides on or near paved surfaces.

While the Federal Insecticide, Fungicide, and Rodenticide Act authorizes the U.S. Environmental Protection Agency to restrict pesticide use to the extent necessary to prevent unreasonable adverse environmental effects, it does not exempt pesticide discharges from the Federal Clean Water Act, which does not specifically recognize any possible economic, social, or environmental costs or benefits of pesticide use.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

The Water Boards and the Department of Pesticide Regulation operate within the California Environmental Protection Agency. The Water Boards enforce California's Porter-Cologne Water Quality Control Act and portions of the Federal Clean Water Act. The Department of Pesticide Regulation implements portions of California's Food and Agricultural Code and the Federal Insecticide, Fungicide, and Rodenticide Act.

Water Boards

In the Bay Area, the Water Boards are primarily responsible for enforcing water quality standards. The Porter-Cologne Water Quality Control Act requires Water Boards to adopt water quality control plans (Basin Plans) for waters within their regions (Water Code § 13240). In formulating these plans, Water Boards must consult with affected state and local agencies. Water Boards are also required to review and revise these plans periodically. Basin Plans contain water quality objectives to protect beneficial uses (Water Code § 13241). Basin Plan objectives apply to pesticide discharges and their resultant aquatic toxicity (see Section 5, "Project Description").

Water Code § 13242 requires Water Boards to establish programs of implementation for achieving water quality objectives. These programs must include a description of the actions necessary to achieve water quality objectives, including recommendations for action by any entity, public or private. The programs must also include time schedules and descriptions of surveillance to be undertaken to determine compliance with objectives.

The San Francisco Bay Basin Plan prohibits the discharge of "biocides…which have…characteristics of concern to beneficial uses when applied where direct or indirect discharge to water is threatened except where net environmental benefit can be demonstrated…." This prohibition is intended to minimize the toxic effects of pesticides on aquatic life.

The Porter-Cologne Water Quality Control Act requires that all California agencies comply with the Basin Plan (Water Code §13247):

> *State offices, departments, and boards, in carrying out activities which may affect water quality, shall comply with water quality control plans approved or adopted by the state board unless otherwise directed or authorized by statute, in which case they shall indicate to the regional boards in writing their authority for not complying with such plans.*

Water Code §13225 places the following responsibilities, among others, on the Water Boards:

> *(a) Obtain coordinated action in water quality control, including the prevention and abatement of water pollution and nuisance….*
>
> *(c) Require as necessary any state or local agency to investigate and report on any technical factors involved in water quality control or to obtain and submit analyses of water; provided that the burden, including costs, of such reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained therefrom.*
>
> *(d) Request enforcement by appropriate federal, state and local agencies of their respective water quality control laws….*

The Water Boards have the authority to issue and enforce National Pollutant Discharge Elimination System (NPDES) permits for point-source discharges, including urban runoff discharged through storm drains, pursuant to the Federal Clean Water Act. The Porter-Cologne Water Quality Control Act authorizes the Water Boards to issue and enforce Waste Discharge

Requirements for point and non-point source discharges. The Water Boards can also waive Waste Discharge Requirements for certain discharges, with or without conditions on such waivers. Water Board enforcement tools include, but are not limited to, time schedule orders, cease and desist orders, and cleanup and abatement orders.

Department of Pesticide Regulation

The Department of Pesticide Regulation regulates pesticide sales and use within California. It has authority over those who distribute and sell pesticides and pesticide users, including professionals and those who apply over-the-counter products. Department of Pesticide Regulation regulations can be more stringent than U.S. Environmental Protection Agency regulations. Although the Department of Pesticide Regulation cannot change a U.S. Environmental Protection Agency-approved pesticide label, it can restrict pesticide use in California by requiring a permit to apply a particular pesticide. The permit can include conditions, such as additional training requirements, special handling practices, or specific prohibitions. The authority to enforce such permits is generally delegated to County Agricultural Commissioners.

California Food and Agricultural Code §12824 grants the Department of Pesticide Regulation broad authority to regulate pesticides to protect water quality:

> *The director [of the Department of Pesticide Regulation] shall endeavor to eliminate from use in the state any pesticide that endangers the agricultural or nonagricultural environment…. Appropriate restrictions may be placed upon [a pesticide's] use including, but not limited to, limitations on quantity, area, and manner of application.*

California Food and Agricultural Code §12825 states the following:

> *…the director, after hearing, may cancel the registration of, or refuse to register, any pesticide:*
>
> *(a) That has demonstrated serious uncontrollable adverse effects either within or outside the agricultural environment.*
>
> *(b) The use of which is of less public value or greater detriment to the environment than the benefit received by its use.*
>
> *(c) For which there is a reasonable, effective, and practicable alternate material or procedure that is demonstrably less destructive to the environment….*
>
> *In making a determination…, the director may require those practical demonstrations that are necessary to determine the facts.*

California Food and Agricultural Code §14102 states the following:

> *The director shall prohibit or regulate the use of environmentally harmful materials….*

The Department of Pesticide Regulation has broad discretion in determining what it considers to be environmental harm; however, the California Code of Regulations (Title 3, §6158) describes factors to be considered when registering a pesticide:

> *During the review and evaluation of proposed pesticide labeling and data to support registration, the director shall give special attention…to each of the following factors, when applicable, in reaching a decision to register or not register the pesticide:…*
>
> *(c) Potential for environmental damage, including interference with the attainment of applicable environmental standards (e.g., air quality standards and water quality objectives).*
>
> *(d) Toxicity to aquatic biota or wildlife….*
>
> *If any of these factors are anticipated to result in significant adverse impacts which cannot be avoided or adequately mitigated, registration will not be granted unless the director makes a written finding that anticipated benefits of registration clearly outweigh the risks.*

To the extent that the U.S. Environmental Protection Agency may not have accounted for water quality standards in its pesticide registration process, the Department of Pesticide Regulation can ensure that pesticides registered in California do not result in discharges that exceed water quality objectives. Any time the Department of Pesticide Regulation receives evidence that a registered pesticide may have caused, or is likely to cause, a significant adverse impact on the environment, it can initiate a re-evaluation process (Title 3, California Code of Regulations, §6220 et seq.). It can also re-evaluate a pesticide if an effective and feasible alternative material or procedure is available that poses less environmental risk. During re-evaluation, the Department of Pesticide Regulation is authorized to request relevant information or studies from pesticide registrants. Based on the information it receives, it can restrict or ban pesticide applications in California. All registered pesticide products are subject to continuous evaluation (Title 3, California Code of Regulations, §6226).

Coordination Within the California Environmental Protection Agency

The Department of Pesticide Regulation and the Water Boards have been working together to address pesticide-related toxicity in California waters. The agencies signed a management agency agreement in 1997, and in 2003, the Department of Pesticide Regulation developed a process it and the Water Boards can use to cooperatively respond to pesticides in surface water.

Management Agency Agreement. To address pesticide-related toxicity in California waters, the Department of Pesticide Regulation and the Water Boards entered into an agreement that clarifies their roles and how their roles are to be coordinated, particularly in instances where water quality standards are violated (CDPR et al. 1997). The agencies agreed to promote the development and implementation of reduced-risk practices whenever necessary to protect beneficial uses from potentially adverse effects of pesticides. The agreement anticipates a four-stage approach: (1) education and outreach to communicate pollution prevention strategies; (2) self-regulating or cooperative efforts to identify and implement reduced-risk practices; (3) mandatory requirements through restricted use pesticide permits, regulations, or other Department of Pesticide Regulation authorities; and (4) mandatory requirements through Basin Plan actions or other Water Board regulations. The agreement states that these stages need not be implemented in order. The Water Board's current effort to adopt a water quality attainment strategy to address pesticide-related toxicity in urban creeks can be considered stage 4.

Process for Responding to the Presence of Pesticides in Surface Water. The Department of Pesticide Regulation developed a process it and the Water Boards can use to cooperatively respond to pesticide-related water quality standard violations in surface water (CDPR 2003b). The process addresses situations when (1) the Water Boards determine that water quality objectives are violated or (2) the Water Boards have not formally stated that water quality objectives are violated, but the Department of Pesticide Regulation believes that water quality issues may be of concern. Consistent with the process, if warranted, the Department of Pesticide Regulation can require pesticide registrants to submit additional data through its re-evaluation process, direct registrants to mitigate problems or face actions on registrations, add pesticides to the list of restricted materials requiring permits based on conditions necessary to attain water quality standards, adopt regulations that impose additional use requirements, refuse to register certain pesticides, or cancel registrations. The Water Boards can issue or rescind waste discharge requirements, issue conditional waivers of waste discharge requirements, or take various enforcement actions. The "Process for Responding to the Presence of Pesticides in Surface Water" does not address situations where the Water Board has evidence that a pesticide poses a likely threat to water quality without definitive proof that water quality standards have been violated.

LOCAL AGENCIES

Urban Runoff Management Agencies

Most urban runoff flows through municipal storm drains, which are point sources subject to National Pollutant Discharge Elimination System permits. Therefore, the Water Boards directly oversee municipal urban runoff management agencies through the National Pollutant Discharge Elimination System permit program. These permits require that discharges from storm drains not cause or contribute to violations of applicable water quality standards, including toxicity standards. Permit holders are required to reduce pollutant discharges to the maximum extent practicable. The Code of Federal Regulations (Title 40, §122.26[d][2][iv]) requires program implementation:

> *…to reduce, to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer which will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.*

However, California Food and Agricultural Code §11501.1 significantly limits municipal authority to oversee pesticide applications:

> *[Most California pesticide laws] are of statewide concern and occupy the whole field of regulation regarding the registration, sale, transportation, or use of pesticides to the exclusion of all local regulation. Except as otherwise specifically provided in this code, no ordinance or regulation of local government, including, but not limited to, an action by a local governmental agency or department, a county board of supervisors or a city council, or a local regulation adopted by the use of an initiative measure, may prohibit or in any way attempt to regulate any matter relating to the registration, sale, transportation, or use of pesticides, and any of these ordinances, laws, or regulations are void and of no force or effect.*

These restrictions pose significant compliance liabilities for municipalities with urban runoff permits, wherein the municipalities are accountable for the presence of pesticides in their discharges but do not have the authority to regulate pesticide applications within their jurisdictions. Each municipality can, however, determine how it manages pesticides within its own operations.

County Agricultural Commissioners

Bay Area counties with urban runoff permits may use the authorities vested in their County Agricultural Commissioners to minimize pesticide discharges. The California Department of Pesticide Regulation delegates certain authorities to County Agricultural Commissioners, including enforcement authority for pesticides applied professionally and pesticides sold over-the-counter. In addition, California Food and Agricultural Code §11503 allows County Agricultural Commissioners to adopt local regulations that govern the conduct of pest control operations and the records and reports of those operations. To adopt such regulations, County Agricultural Commissioners must follow the rulemaking provisions of California's Administrative Procedure Act and the Director of the California Department of Pesticide Regulation must review them. According to California Food and Agricultural Code §11738, County Agricultural Commissioner regulations may require pest control professionals to pass an examination prior to operating pest control equipment (other than aircraft) (CDPR 2003c).

OTHER RELEVANT GOVERNMENT ENTITIES

Other relevant government organizations include the California Department of Consumer Affairs (i.e., the Structural Pest Control Board) and the University of California Statewide Integrated Pest Management Program.

- ***Department of Consumer Affairs***. The Structural Pest Control Board, which is within the Department of Consumer Affairs, is responsible for licensing structural pest control operators. The Structural Pest Control Board requires training and examinations to maintain a license to practice structural pest control, and regulates the advertising practices of structural pest control operators. Structural Pest Control Board regulations (California Code of Regulations, Title 16, §1999.5[f]) forbid licensed pest control professionals from stating that any pest control service or product protects or benefits the environment. This includes statements that any pesticide products are relatively less toxic or environmentally preferable, even if the statements can be substantiated. This regulation restricts the ability of pest control professionals to explain the relative environmental merits of integrated pest management, which is the core of the implementation plan described in Section 10, Proposed Implementation Actions.

- ***University of California Statewide Integrated Pest Management Program***. The University of California Statewide Integrated Pest Management Program is responsible for pest management education and outreach throughout California. It is not a regulatory agency and has no regulatory authorities. However, its advisors develop, demonstrate, and adapt effective pest management techniques and disseminate research-based pest management information. The Statewide Integrated Pest Management Program publishes and distributes the University of California's official Pest Management Guidelines for urban and agricultural pests. The University of California also conducts regional outreach through its Cooperative Extensions.

GAPS IN REGULATORY PROGRAM IMPLEMENTATION

Pesticide-related water quality impairment occurs, in large part, because of gaps in regulatory program implementation stemming from differing federal mandates (i.e., the Federal Insecticide, Fungicide, and Rodenticide Act versus the Federal Clean Water Act). The U.S. Environmental Protection Agency's Office of Pesticide Programs implements the Federal Insecticide, Fungicide, and Rodenticide Act and its Office of Water implements the Federal Clean Water Act. These laws do not address potential environmental effects in the same manner; therefore the Office of Pesticide Programs and the Office of Water evaluate water quality effects differently when fulfilling these mandates. As a result, the Office of Pesticide Program's pesticide registration and reregistration processes do not necessarily ensure compliance with the Federal Clean Water Act as interpreted by the Office of Water.

The U.S. Environmental Protection Agency's registration and reregistration processes involve numerous technical studies and consider many human health and environmental risks in great detail. However, they omit some fundamental water quality issues, as listed below. Most importantly, the Office of Pesticide Programs does not require all information necessary to evaluate and prevent pesticide-related water quality impacts, particularly in the urban environment.

- ***Risk Assessment Methods.*** Office of Pesticide Programs pesticide risk assessments differ from those the Office of Water uses to assess water quality. The most significant differences relate to their approaches to establishing protective levels for aquatic life. Specifically, they relate to the minimum data required to establish levels of concern, the sources and types of data collected, and the criteria for acceptable studies. In general, Office of Water methods use more data sources, more species, and more protective approaches to determine appropriate levels (USEPA 2002c). As a result, the Office of Pesticide Programs registers pesticides for applications that can potentially result in violations of water quality standards (USEPA 2002d; USEPA 2003b,d).

- ***Urban Application Sites.*** When registering most pesticides, the Office of Pesticide Programs prepares an environmental risk assessment that analyzes the environmental fate of the pesticide, estimates its foreseeable environmental concentrations, and compares the estimated concentrations to thresholds determined from aquatic toxicity data. These risk assessments typically involve relatively detailed analyses of agricultural pesticide applications using sophisticated environmental models. The Office of Pesticide Programs does not currently have models to estimate surface water concentrations resulting from urban pesticide applications; therefore, it does not characterize the fate and transport of pesticides applied in urban areas (e.g., runoff from paved surfaces) (USEPA 2003d). Important environmental risks could be neglected as a result of this gap. Office of Pesticide Programs risk assessments for malathion and carbaryl found significant ecological risks related to agricultural applications, but the urban risks may have been understated because, nationwide, concentrations of these pesticides are higher in urban areas (Gilliom et al. 1999).

- ***Environmental Endpoints.*** Office of Pesticide Programs agricultural models do not estimate pesticide concentrations in sediment, where pesticides, such as pyrethroids, are likely to accumulate. Consequently, important environmental endpoints, like sediment toxicity, are omitted from Office of Pesticide Programs risk assessments (USEPA 2000a).

- ***Water Quality Criteria Data.*** The Office of Pesticide Programs requires aquatic toxicity tests as part of its pesticide registration process. However, the standard toxicity test species for pesticide registration (Title 40, Code of Federal Regulations, Part 158) differ from those required to test for aquatic toxicity under the Federal Clean Water Act (Title 40, Code of Federal Regulations, Part 136). Moreover, the toxicity tests required for registration do not include the minimum data necessary to derive acute and chronic water quality criteria using Office of Water guidelines (USEPA 1985). For example, after reviewing available toxicity data for four common pyrethroids, the California Department of Fish and Game determined that data were adequate only to develop an acute criterion for permethrin in salt water and, because of data limitations, interim acute criteria for permethrin and cypermethrin in fresh water (CDFG 2000a). Data were inadequate to develop other acute and chronic criteria for permethrin, cypermethrin, bifenthrin, and esfenvalerate in fresh and salt water.

- ***Cumulative Environmental Assessment.*** Multiple pesticides with similar mechanisms of toxicity can have cumulative (e.g., additive) effects. Registration procedures under the Federal Insecticide, Fungicide, and Rodenticide Act consider environmental effects individually, not cumulatively. The Food Quality Protection Act requires consideration of cumulative human health risks, but not cumulative ecological risks. The Office of Pesticide Programs has begun to evaluate cumulative human health risks, but it has not extended its cumulative analyses to environmental risks (CSQTF 2002).

- ***Chemical Analysis Methods.*** To ensure that pesticide residues can be measured on food, the Office of Pesticide Programs requires pesticide registrants to submit analytical methods for pesticides in food and water. These methods need not be viable for use by typical analytical laboratories, be validated in environmental media like water or sediment, or provide ecologically meaningful detection limits. The U.S. Environmental Protection Agency's Pesticide Program Environmental Chemistry Laboratory evaluates only about 25% of pesticide registrant methods, and because some have deficiencies, the laboratory makes no claims of method validity (USEPA 2002e). Commercial analytical laboratories may not always be able to provide satisfactory analytical results with the methods registrants submit to the U.S. Environmental Protection Agency.

  The growing use of pyrethroids poses analytical challenges. Because pyrethroids are nearly insoluble in water, they bind strongly to any type of surface, including the surfaces of test containers and equipment (Laskowski 2002). With the most sensitive methods, pyrethroids can be measured at concentrations below levels lethal to test species in both water and sediment, but the lower concentrations associated with sub-lethal effects cannot be detected (Amweg et al. 2005b). Capabilities for measuring environmentally relevant concentrations of pyrethroids in water and sediment are improving, but additional work is needed to validate these analytical methods in environmental samples. The availability of any commercial laboratory analytical methods capable of measuring environmentally relevant concentrations of pyrethroids is a recent development (SFEP 2005b). Although U.S. Environmental Protection Agency Toxicity Identification Evaluation procedures are available for determining the identities of toxic substances, chemical fingerprints are not yet available to identify specific pyrethroids (Miller et al. 2002; SFEP 2005b).

- ***Effects of Formulations.*** The Office of Pesticide Programs addresses environmental effects of "active" and "inert" pesticide ingredients through separate registration processes. These reviews are unable to evaluate how the environmental fate and effects of formulated products differ from those of the individual ingredients.

Formulated products have different environmental properties than their individual ingredients, as discussed in Section 8, "Linkage Analysis" (CDPR 2001b).

Water Board staff tracks U.S. Environmental Protection Agency pesticide registration processes, and when invited, submits comments. The comments call attention to gaps in regulatory program implementation that could affect water quality (SFBRWQCB 2000; SFBRWQCB 2001a,b; SFBRWQCB 2002a,b,c; SFBRWQCB 2003b; SFBRWQCB 2004b,d,e,g; SFBRWQCB 2005a,b,f).

Under California law, the California Department of Pesticide Regulation has authority to close many of the data gaps discussed above and limit water quality impacts from pesticides. For example, the California Department of Pesticide Regulation must annually review the registration of all pesticide products and conduct environmental review under the California Environmental Quality Act. In registering a pesticide product, the California Department of Pesticide Regulation can consider factors such as the availability of alternatives that pose less risk to the environment. In practice, however, these gaps are rarely addressed.

The California Department of Pesticide Regulation undertakes over 5,000 pesticide product registration actions each year with limited resources. In making these decisions, it considers only information that product registrants provide. This usually includes information provided to the U.S. Environmental Protection Agency, but it does not typically include the risk assessments that the U.S. Environmental Protection Agency prepares. Moreover, the California Department of Pesticide Regulation does not complete its own environmental risk assessments. It does not undertake any quantitative or qualitative urban runoff assessment for most urban pesticide product applications. In fact, does not typically review any water quality issues related to most urban pesticide applications (e.g., uses of pesticides on paved surfaces) (SFBRWQCB 2005e).

KEY POINTS

- Agencies with the broadest authorities to oversee pesticide use and pesticide discharges include the U.S. Environmental Protection Agency and the California Environmental Protection Agency (including the California Department of Pesticide Regulation and the Water Boards).
- Through National Pollutant Discharge Elimination System permits, Bay Area urban runoff management agencies are responsible for storm drain discharges, but California law prohibits them from regulating the registration, sale, transportation, or use of pesticides within their jurisdictions.
- Gaps in regulatory program implementation allow pesticides to be used in ways that result in discharges that adversely affect urban creek water quality.

5. PROJECT DESCRIPTION

On the basis of the information presented in the previous sections, this section assesses the impairment of Bay Area urban creeks and proposes a Basin Plan Amendment to address existing impairment and the potential for future impairment.

IMPAIRMENT ASSESSMENT

The Basin Plan contains the following narrative objective applicable to toxicity in urban creeks:

> *All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters….*
>
> *There shall be no chronic toxicity in ambient waters. Chronic toxicity is a detrimental biological effect on growth rate, reproduction, fertilization success, larval development, population abundance, community composition, or any other relevant measure of the health of an organism, population, or community….*

The Basin Plan also contains the following narrative objective for sediment:

> *…Controllable water quality factors shall not cause a detrimental increase in the concentrations of toxic pollutants in sediments or aquatic life.*

In addition, the Basin Plan contains the following narrative objective related to population and community ecology:

> *All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce significant alterations in population or community ecology or receiving water biota. In addition, the health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.*

As discussed in Section 2, "Water Quality Conditions," available Bay Area urban creek toxicity data suggest that, at certain times, these narrative water quality objectives are not met. While samples collected from Bay Area creeks draining open space are generally not toxic to *Ceriodaphnia dubia*, some samples collected from urban areas, including some recent samples, have been lethal to *Ceriodaphnia dubia* (BASMAA 1996; SFBRWQCB 2005d). Recent studies indicate that pyrethroid pesticides cause sediment toxicity in at least some Bay Area urban creeks. Therefore, urban creeks are not free of toxic substances in concentrations that are lethal to aquatic organisms, and the Basin Plan's narrative objectives, as stated above, are not met. As a result, habitat-related beneficial uses of Bay Area urban creeks, including cold and warm freshwater habitat, are impaired.

Table 1.1 lists the 37 Bay Area creeks formally designated as impaired. They include those that (1) drain to San Francisco Bay, (2) have been designated in the Basin Plan as having beneficial uses related to aquatic life, and (3) are within the jurisdiction of the Bay Area Stormwater Management Agencies Association (SFBRWQCB 1998). Creeks within the Bay Area Stormwater Management Agencies Association's jurisdiction drain primarily urban and suburban areas. Tributaries of the impaired creeks are also considered impaired.

Many urban creeks are not specifically identified in the Basin Plan and, therefore, are not formally designated as impaired. Water Board staff are working to update the Basin Plan to add some existing Bay Area urban creeks, including (but not necessarily limited to) those listed in Table 5.1. Nevertheless, all urban creeks are likely impaired, regardless of whether they have been formally listed as impaired pursuant to Clean Water Act §303(d), because urban Bay Area watersheds have similar land use patterns, hydrology, and pesticide use patterns, resulting in similar pesticide runoff scenarios.

Few differences in pesticide use patterns are readily apparent among urban watersheds (UC IPM 2003). Data availability does vary, however, among Bay Area creeks. In some cases, such as with Castro Valley Creek, San Lorenzo Creek, and some other creeks in Alameda County, a wealth of information is available. In other areas, only a few or no measurements have been made. As discussed in Section 2, "Water Quality Conditions," toxicity has been observed in a number of Bay Area urban creeks, and diazinon concentrations in urban creeks throughout the Bay Area have at times been within the range of concentrations toxic to *Ceriodaphnia dubia*. Therefore, available evidence indicates that pesticide-related toxicity in urban creeks has been a widespread problem. The pesticide-related toxicity observed in cities outside the Bay Area reinforces this conclusion (Bailey et al. 2000). For this reason, urban creeks for which little information is available are as likely to be impaired as those for which more information is available, regardless of whether the creeks have been specifically monitored for toxicity.

TABLE 5.1
Some Bay Area Urban Creeks Not Named in Basin Plan

County	Creek		
Alameda County	Arroyo Viejo	Laguna Creek	Sulphur Creek
	Codornices Creek	Peralta Creek	Temescal Creek
	Crandall Creek	Sausal Creek	Ward Creek
	Dry Creek	Strawberry Creek	
Contra Costa County	Baxter Creek	Kirker Creek	Refugio Creek*
	Cerrito Creek	Garrity Creek	Rheem Creek
San Mateo County	Belmont Creek	Laurel Creek	San Bruno Creek
	Colma Creek	Mill Creek	Sanchez Creek
	Cordilleras Creek	Pulgas Creek	

* Refugio Creek was added to the Basin Plan in 1995 without explicitly designating beneficial uses.

Management strategies will be most effective if implemented on a regional basis (as opposed to creek-by-creek); therefore, this water quality attainment strategy is designed for all urban creeks, including those not designated as impaired. All urban creeks will benefit from the management efforts implemented through this strategy.

PROJECT DESCRIPTION

Project Definition

The project is the adoption of a Basin Plan Amendment (see Appendix A) to establish a water quality attainment strategy that addresses pesticide-related toxicity in Bay Area urban creeks, including diazinon-related toxicity.

Changes to Basin Plan Chapter 3. The Basin Plan Amendment removes unnecessary and not entirely accurate text regarding chronic toxicity. It also removes text that appears to limit how the Water Board can evaluate toxicity and replaces it with text that clarifies that the Water Board can consider all relevant information. These changes do not alter the water quality objective.

Changes to Basin Plan Chapter 4. The Water Board must develop a TMDL to address the urban creeks designated as impaired pursuant to Clean Water Act §303(d)(1), and the water quality attainment strategy set forth in the proposed Basin Plan Amendment meets this requirement. The strategy also serves as a TMDL for urban creeks not formally listed as impaired pursuant to Clean Water Act §303(d)(1) because evidence does not indicate that conditions in these waters are substantially different than conditions in the formally listed creeks. Even though these creeks are not formally listed as impaired, a TMDL is permissible under Clean Water Act §303(d)(3) and California law. By focusing on pesticide-related toxicity and not exclusively on diazinon, the strategy prevents future impairment by pesticides other than diazinon, including diazinon-replacement pesticides. In this sense, the strategy seeks not only to eliminate any existing pesticide-related impairment, but to prevent such impairment in the future.

The Basin Plan Amendment includes the following regulatory provisions:

1. Numeric targets for pesticide-related toxicity and diazinon concentrations;
2. Total maximum load for diazinon and pesticide-related toxicity (expressed in terms of diazinon concentration and toxic units);
3. Allocations among sources; and
4. Implementation and monitoring provisions to be implemented by urban runoff management agencies and similar entities.

Project Necessity

The broad approach to pesticide-related toxicity set forth in the Basin Plan Amendment (as opposed to a narrow focus on diazinon alone) is warranted considering that, in California, roughly 75% of pesticide use by weight occurs in urban areas (SFEP 2005a) and the existing Basin Plan for the heavily urban San Francisco Bay Region provides little guidance in terms of how water quality standards that relate to pesticide discharges are to be implemented. The proposed Basin Plan Amendment better describes how existing water quality standards will be implemented in terms of pesticide-related toxicity. Moreover, the regulatory provisions listed above are necessary to meet the mandates of Clean Water Act §303(d)(1) and §303(d)(3). The specific necessity of each regulatory provision is as follows:

1. The numeric targets are needed to interpret the narrative water quality objectives in terms of monitoring metrics that reflect the beneficial uses to be protected.
2. The total maximum load is needed to form the basis of the allocations.
3. The allocations among sources are needed to ensure that discharges do not exceed the loading capacity of the urban creeks.
4. The implementation and monitoring provisions are needed to ensure that the allocations, and therefore the numeric targets, are met.

Project Objectives

The proposed Basin Plan Amendment is designed to eliminate and prevent the potential for registered pesticides to cause toxicity in urban creeks and, specifically, to eliminate and prevent water quality impairment attributed to pesticide-related toxicity, including diazinon-related toxicity. Project objectives include the following:

- Comply with requirement to complete TMDLs for diazinon and pesticide-related toxicity in Bay Area urban creeks.
- Attain water quality objectives applicable to Bay Area urban creeks.
- Protect Bay Area urban creek beneficial uses, specifically those related to cold and warm freshwater habitat.
- Set targets to attain relevant water quality standards (objectives and beneficial uses) in urban creeks.
- Comply with antidegradation requirements of State Water Resources Control Board Resolution No. 68-16 and federal antidegradation regulations (Code of Federal Regulations, Title 40, §131.12).
- Provide a margin of safety that accounts for uncertainties in the targets, TMDL, and allocations.
- Ensure that the burden of strategy implementation is shared appropriately by those responsible for pesticide use that threatens water quality.
- Initiate actions to eliminate pesticide-related toxicity based on available information, while continuing to accommodate new information as it becomes available.
- Capitalize on the experience and expertise of the Water Board and the stakeholder community regarding local watersheds and pesticide discharges.
- Ensure that the resources devoted to developing and adopting the strategy result in the greatest water quality benefit possible, both now and in the future.
- Avoid actions that will have unreasonable costs relative to their environmental benefits.

KEY POINTS

- Bay Area urban creeks do not meet the Basin Plan's narrative objectives for toxicity, sediment, and population and community ecology.
- Water Board staff propose adoption of a Basin Plan Amendment to establish a water quality attainment strategy and TMDL that addresses pesticide-related toxicity in urban creeks.
- Because all Bay Area urban creeks can reasonably be assumed to receive pesticide discharges, and because implementation actions will be most efficient if applied region-wide, the strategy applies to all Bay Area urban creeks, including those not formally designated as impaired pursuant to Clean Water Act §303(d)(1).
- The proposed Basin Plan Amendment includes regulatory provisions that are needed to meet water quality objectives and protect beneficial uses of urban creeks.

TMDL Analyses

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6. SOURCE ASSESSMENT

This section summarizes sources and conveyances (i.e., pathways carrying pollutants) of pesticides, including diazinon, to Bay Area urban creeks. It describes available formulations, common application sites, and typical target pests, and discusses how these factors affect pesticide runoff. It also identifies the entities most responsible for pesticide discharges.

SOURCES OF PESTICIDES IN URBAN CREEKS

Primary Conveyances

The predominant pathways through which a pesticide applied in an urban area might reach a Bay Area urban creek are storm water runoff, dry weather discharges from storm drains, and possibly direct discharges (e.g., dumping) (CDPR 2001b). This conclusion follows from the elimination of the other conceivable pathways discussed below. Storm drains are believed to convey essentially all the pesticides found in urban creeks. Storm water runoff and dry weather discharges both flow through storm drains. For purposes of this report, the term "urban runoff" includes all flows from developed areas, including industrial sites, construction sites, and rights of way (e.g., California Department of Transportation highways).

For a particular creek, the urban runoff that flows into the creek is the immediate source of pesticides to that creek. Storm drains carry most urban runoff and are regulated as point sources. All Bay Area municipalities are subject to National Pollutant Discharge Elimination System permits for their storm drain discharges. In the Bay Area, the Water Board issues and administers these permits for municipalities representing the largest populations. Other municipalities and some large institutional dischargers (e.g., universities and military bases) operate under a statewide permit. Industrial and construction dischargers and the California Department of Transportation also operate under statewide permits.

Direct pesticide discharges to surface water could occur; however, the relative size of the urban areas draining directly to creeks via overland flow is very small compared to the relative size of urban areas draining to storm drains. Pesticide discharges resulting from normal use, random illicit activity, or accidental spills, therefore, are far more likely to flow into a storm drain than directly into a creek. Regardless of this distinction, however, the pest management activities that result in direct pesticide discharges to urban creeks and discharges to storm drains are essentially the same. Therefore, this report does not address them separately. In a few instances, pesticides are applied directly to urban creeks (e.g., for exotic weed management), but such discharges are subject to National Pollutant Discharge Elimination System permits that limit the potential for toxicity to occur beyond the application site.

Conceivable but Improbable Conveyances

Figure 6.1 shows conceivable pathways through which a pesticide might reach surface water. In the context of Bay Area urban creeks, many of these pathways are unlikely to be important. Most municipal wastewater treatment plants do not discharge into urban creeks. Their discharges flow directly to San Francisco Bay or the Pacific Ocean. Only Calistoga, Yountville, and St. Helena do discharge into freshwater, and they have no record of discharging pesticide-related toxicity (SFBRWQCB 2005c). A few industrial and commercial operations discharge wastewater into urban creeks, but none are known sources of any registered pesticides. Shipping and boating do not typically occur in Bay Area urban creeks; therefore, they are not known pesticide conveyances to urban creeks.

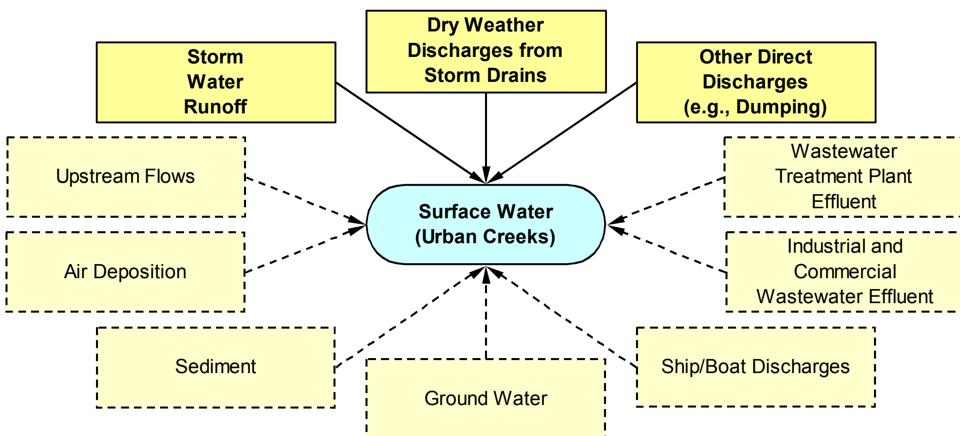

FIGURE 6.1
Conceivable Pathways for a Pesticide To Reach Surface Water

Watersheds upstream from Bay Area urban areas are primarily open space; consequently, upstream flows are not important conveyances of pesticides to urban creeks. In the nine Bay Area counties, roughly 93% of pesticides by weight are applied in urban areas. Agricultural pesticide use is considerably smaller by comparison, accounting for roughly 7%, which overstates the agricultural use in the Bay Area as explained in Section 3, "Pesticide Use Trends" (TDC 2005b).

Air deposition could contribute pesticides to upstream flows, but air deposition is primarily a conveyance mechanism for pesticides from other Bay Area sources (see Section 8, "Linkage Analysis"). Winds entering the Bay Area typically arrive from the Pacific Ocean, thereby limiting the potential for atmospheric deposition from regions beyond the Bay Area. Sediment is a conveyance that carries pesticides from place to place when pesticide-laden particles reach a creek or pesticides bind to particles within a creek (see Section 8, "Linkage Analysis"), but it is not a source.

Groundwater could convey water-soluble pesticides to urban creeks. However, most likely diazinon replacements (e.g., pyrethroids, as discussed in Section 3, "Pesticide Use Trends") adhere strongly to particles (SFBRWQCB 2003a). Diazinon, which is generally more soluble than the pyrethroids, adheres reasonably strongly to particles and is seldom found beyond the top 0.5 inches of affected soil (ETN 1996). Diazinon has been detected in less than 2% of shallow groundwater samples from urban areas, with the highest concentration reported being 10 ng/l (USEPA 2000f).

Pesticide Sources

Most pesticides, like diazinon and the pyrethroids, do not occur naturally in the environment; they are manufactured. (The pyrethrins described in Table 3.4 are an exception.) Makhetshim-Agan manufactures diazinon and is currently the only technical registrant. Other manufacturers and formulators also exist. As shown in Figure 6.2, pesticide manufacturers and formulators (companies that formulate commercial products with pesticides manufactured by others) sell products to distributors and retailers. Retailers sell them to the private citizens, structural pest control operators, professional landscape maintenance gardeners, and agricultural users who apply them. In the Bay Area, the pesticide runoff that flows to urban creeks results from pesticide applications by these pesticide users. Pesticide manufacturers, formulators, distributors, and retailers share responsibility with these dischargers for pesticides found in urban creeks.

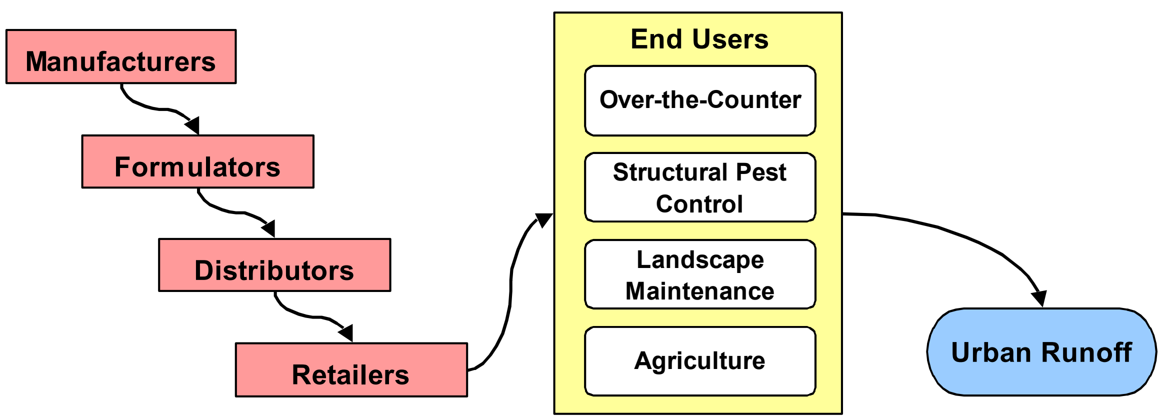

FIGURE 6.2
Entities Responsible for Pesticide Discharges

Pesticide users vary by pesticide. Given annual average diazinon applications from 1995 to 1999 (see Section 3, "Pesticide Use Trends"), and assuming that reported and unreported applications were each about 50% of the total (ACFCWCD 1997), the total amount of diazinon applied in the Bay Area was probably distributed among over-the-counter use, structural pest control, agriculture, and landscape maintenance roughly as illustrated in Figure 6.3. Over-the-counter diazinon use was the largest fraction. As

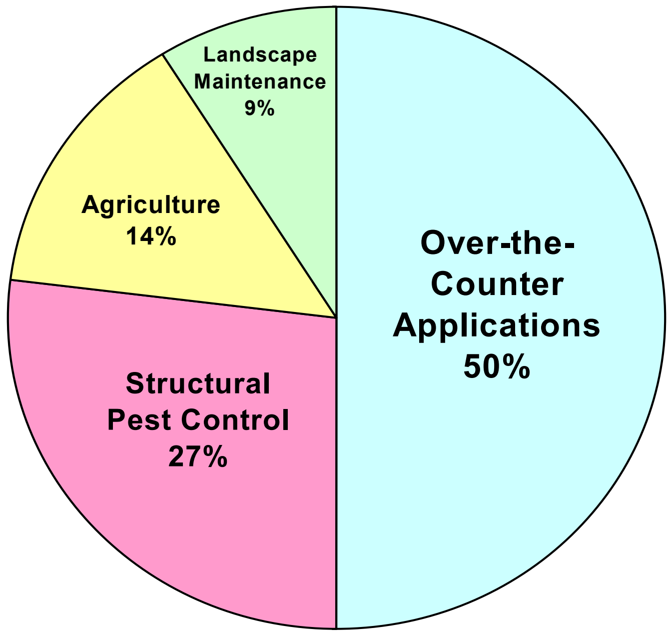

FIGURE 6.3
Distribution of Bay Area Diazinon Applications, 1995-1999

shown in Figure 6.4, about 42% of Bay Area residents purchase their pesticides from large home supply stores (essentially Home Depot and Lowes). About 20% of private citizens purchase their pesticides from hardware stores, such as Orchard Supply Hardware and ACE Hardware (UC IPM 2003).

The relative use of diazinon replacement pesticides could be similar to the distribution shown in Figure 6.3. However, an analysis of 2003 pesticide use reports and statewide sales data suggests that many diazinon alternatives are applied primarily for structural pest control, as shown in Table 6.1. On a mass basis, structural pest control professionals apply about half of the pyrethroids used in urban areas; however, the pyrethroids most structural pest control professionals choose tend to be more toxic in sediment than those sold over-the-counter. If weighted in terms of relative sediment toxicity, structural pest control professionals apply over 70% of the pyrethroid toxicity used in urban areas (SFEP 2005a). The relative potential for structural pest control pyrethroid applications to run off compared to pyrethroids sold over-the-counter is unknown, but structural pest control is apparently an important potential source of pesticide-related toxicity in urban creeks.

Distribution of Pesticides Within the Watershed

The distribution of pesticide residues in urban creeks provides clues about how they are applied in urban areas and the paths they take to reach surface water. Although the pesticides expected to serve as alternatives for diazinon have not been monitored

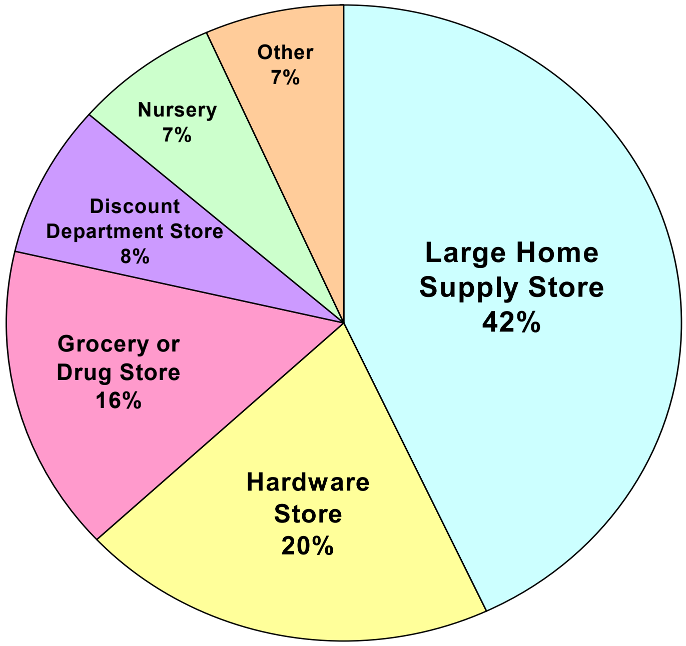

FIGURE 6.4
Retailers Where Bay Area Residents Buy Pesticides

extensively in Bay Area urban creeks, diazinon patterns may provide useful insights into their likely distribution.

The Alameda Countywide Clean Water Program investigated the Castro Valley Creek watershed, which is typical of many Bay Area urban watersheds. On the basis of numerous concentration measurements and corresponding flow data, Alameda County estimated the total amount of diazinon discharged to Castro Valley Creek to be about 1.3 pounds during the 1995-1996 rainy season. This load represents a very small fraction (about 0.25%) of the diazinon Alameda County estimated was applied outdoors in the watershed (ACCWP and ACFCWCD 1997). This fraction is consistent with runoff observed from routine applications in other areas (Capel et al. 2001). Assuming that about 0.25% of the 90 tons of diazinon applied annually throughout the entire Bay Area from 1995 through 1999 found its way to surface water (see Section 3, "Pesticide Use Trends"), the Bay Area's total annual urban runoff diazinon load was roughly 450 pounds.

Analysis of urban runoff samples collected from the Castro Valley Creek watershed indicated that diazinon applied on surfaces during dry weather appeared to accumulate before washing into the creek during storms. The mass of diazinon discharged to the creek increased with increased flow, although diazinon concentrations decreased, presumably through dilution. Diazinon concentrations were higher in residential and commercial areas compared to those with more open space. Higher diazinon levels were not clearly associated with any particular neighborhoods, however, and diazinon samples

Table 6.1
Bay Area Urban Pesticide Use, 2003[a]

Pesticide	Bay Area Urban Use (pounds)[b]	Fraction Applied by Professionals (%)	Most Common Professional Application Sites[c] Structures (%)	Landscapes (%)
Pyrethrins	10,000	3		
Bifenthrin	6,000	73	>80	<20
Cyfluthrin[d]	12,800	37	~100	
Cypermethrin	15,000	~100	~100	
Deltamethrin	1,400	~100	~100	
Esfenvalerate	4,000	~0		
Lambda-Cyhalothrin	600	76	~100	
Permethrin	30,000	75	~60	~40
Carbaryl	30,000	26		~100
Malathion	200,000	1		
Imidacloprid	7,400	~100	>80	<20

[a] Data reflect the nine Bay Area counties. All data are approximate estimates.
[b] The toxicity of different pesticides varies, so use by weight cannot be compared directly.
[c] Data are not provided when professional use is relatively small. Application sites for over-the-counter uses can be assumed to include both structures and landscapes.
[d] Of the 12,800 pounds of cyfluthrin, about 8,000 pounds is beta-cyfluthrin. These data could reflect some stockpiling of new product. About 92% of the beta-cyfluthrin is applied by over-the-counter consumers. Essentially all the rest of the cyfluthrin is applied by professionals.
Source: SFEP 2005a.

from adjacent gutters draining separate residences sometimes exhibited very different concentrations. Diazinon appeared to come from multiple, sporadic sources. Individual sources may have been very localized, and downstream diazinon levels apparently reflected an average of upstream pulses. At any one time, about 2 to 4% of the properties in residential areas could have contributed diazinon to urban runoff. Some consistent diazinon discharges may also have existed in the Castro Valley Creek watershed because some relatively high diazinon concentrations occurred at certain locations during more than one sampling event (ACCWP and ACFCWCD 1997).

The Alameda Countywide Clean Water Program also studied the San Leandro Creek watershed and came to similar conclusions. Street gutter samples collected from residential areas during a storm exhibited low diazinon concentrations in many areas and high levels in a few areas. Creek samples were more uniform and reflected the average of many different storm water discharges (ACCWP 1999b). The data suggested that applications at discrete, variable, and independent locations were responsible for the diazinon observed in surface water. The data did not necessarily suggest runoff from isolated and sporadic illicit or accidental activities, although these could also have contributed to the overall load.

The Alameda Countywide Clean Water Program conducted tests to determine if applying diazinon outdoors in accordance with its label instructions could account for observed surface water concentrations. A liquid diazinon concentrate was diluted and applied at a home in accordance with label instructions (except that the amount of diazinon applied was considerably less than the recommended application rate). During subsequent rainfall, runoff concentrations reached as high as 1,200,000 ng/l several days after the application. The highest runoff concentrations occurred when rain closely followed the application, and high diazinon levels persisted for up to 7 weeks. The study concluded that applying diazinon in accordance with label instructions could not be ruled out as a source of diazinon in urban runoff (ACCWP and ACFCWCD 1997).

Inappropriate pesticide handling could also contribute to pesticide concentrations in urban creeks. In response to a telephone survey of Bay Area residents, about 4% of residents who used pesticide products mixed with water admitted to disposing of leftover product by pouring it in the street, gutter, or drain outside the house. About 1.5% admitted to pouring pesticides they no longer wanted in the street, gutter, or drain outside the house (UC IPM 2003).

FORMULATIONS, APPLICATION SITES, AND TARGET PESTS

Various factors affect pesticide use and potential runoff, including pesticide formulations, application sites, and target pests. Understanding these factors helps in identifying opportunities to reduce pesticide discharges to urban creeks.

Formulations

Manufacturers formulate pesticide products by mixing active ingredients with other chemicals to dilute the pesticide to an appropriate application concentration and to improve properties like storage life, ease of handling, ease of application, effectiveness, and safety. The added ingredients are called “inert” ingredients to differentiate them from “active” ingredients; however, the term “inert” does not imply that these chemicals do not run off or that they are not toxic. The mixture of inert and active ingredients constitutes the formulation. Because of the inert ingredients, each pesticide formulation has unique physical and chemical characteristics that may affect its runoff potential.

Common types of formulations include sprays and foggers; ready-to-use liquids; dusts, powders, granules, and flakes; emulsifiable concentrates (solvent-based concentrates to be diluted with water for sprays); water-based concentrates for sprays; and wettable powders (powdered product to be mixed with water by professional applicators) (SFBRWQCB 2003a). According to a survey of Bay Area residents, most residents (47%) choose ready-to-use spray formulations, as shown in Figure 6.5. Concentrated sprays, enclosed baits, and granules are also common formulations (UC IPM 2003).

The relative effect of formulation on water quality depends on (1) how much product is applied and (2) how much of the pesticide in the formulation typically runs off the site. Wettable powders are widely applied to impervious surfaces by pest control operators,

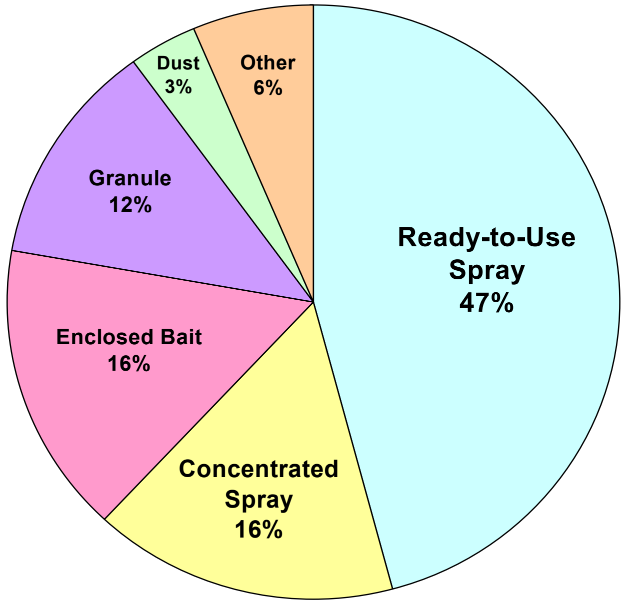

FIGURE 6.5
Over-the-Counter Formulations Used by Bay Area Residents

and when exposed to water (e.g., rain), they are easily re-suspended (CDPR 2001b). Runoff can carry away 2 to 5% of the active ingredient from a typical wettable powder application (Evans et al. 1998). Therefore, wettable powders appear to offer the greatest potential for concern. Emulsifiable concentrates may also be of concern. Water insoluble pesticides applied in emulsion formulations run off more than water-soluble pesticides (Wauchope 1978). Emulsions are also more prone to run off than granules or flakes (CDPR 2001b).

A few studies have compared runoff from different pesticide formulations, as described below:

- A study comparing runoff of liquid and granular diazinon formulations from turf test plots found 0.7 to 1.15% of applied diazinon washed off with relatively light irrigation (0.5 inches). Twice as much diazinon washed off from the emulsifiable concentrate application than from the granules. The difference was attributed to surfactants in the emulsifiable concentrate facilitating wash-off and the need for the granule carrier material (paper) to dissolve before diazinon could wash off (Evans et al. 1998).

- A review of pre-1980 pesticide wash-off studies found that emulsifiable concentrates resist removal by rain more than dusts or wettable powders, perhaps because the emulsifiable concentrate penetrates vegetation (unlike powders, which rest on the surface) (USDA 1980).

- In diazinon turf wash-off experiments conducted on laboratory test plots, 1.5% of a granular formulation was washed off, while 21.8% of an emulsifiable concentrate was washed off. Wash-off was initiated immediately after application, which probably accounts for the relatively high runoff fraction (CDPR 2002b; SFBRWQCB 2003a).

- Formulation had a small effect on imidacloprid wash-off from turf plots. Mean wash-off fractions for four model storms were 1.5% for the wettable powder and 1.9% for granules. In the same tests, the herbicide 2,4-D (2,4-dichlorophenoxy acetic acid) had a reverse pattern, with 3% of the wettable powder application washing off compared to 2.2% of the granular formulation (Armbrust and Peeler 2002).

Application Sites

Indoor applications may result in wastewater discharges, but because most Bay Area wastewater treatment plants do not discharge to urban creeks, indoor applications do not result in substantial discharges to urban creeks. Outdoor pesticide applications pose the greatest potential risks to urban creeks.

According to a telephone survey of Bay Area residents, about 58% of residents apply pesticides to hard surfaces, such as pavement, as shown in Figure 6.6. Of the survey respondents, about 21% reported applying pesticides to lawns or turf, and about 18% reported applying pesticides to ornamental plants (UC IPM 2003). These results closely match those of a more limited telephone survey of Castro Valley residents. Castro Valley's mostly low-density residential development is representative of much of Alameda County. Building foundations, patios, and walkways were common application sites, as well as gardens, trees, shrubs, and lawns (ACFCWCD 1997).

When Bay Area residents who hire professionals to apply pesticides were asked to list the sites where they have pesticides applied, about 92% mentioned hard surfaces, as shown in Figure 6.7. About 33% of survey respondents reported that the professionals apply pesticides to lawns or turf, and about 22% reported applications to ornamental plants (UC IPM 2003).

As with pesticide formulations, the relative effect of application site on water quality depends on (1) how much product is applied at the site and (2) how much of the pesticide at the site typically runs off. On the basis of available data, applications to impervious surfaces appear to pose the greatest concern because significant amounts of pesticides are applied there (CDPR 2001b). Structural pest control applications have been among the most common uses of diazinon, and structural pest control operators apply pesticides to impervious surfaces. As suggested by Figure 6.6, many homeowners also apply over-the-counter pesticide products to impervious surfaces.

Impervious surfaces do not absorb water, so more runoff occurs and more pesticide potentially reaches urban creeks. Pesticides applied to impervious surfaces may also degrade less rapidly than those applied to plants or soil because on impervious surfaces they are exposed to less microbial degradation (USEPA 2000f).

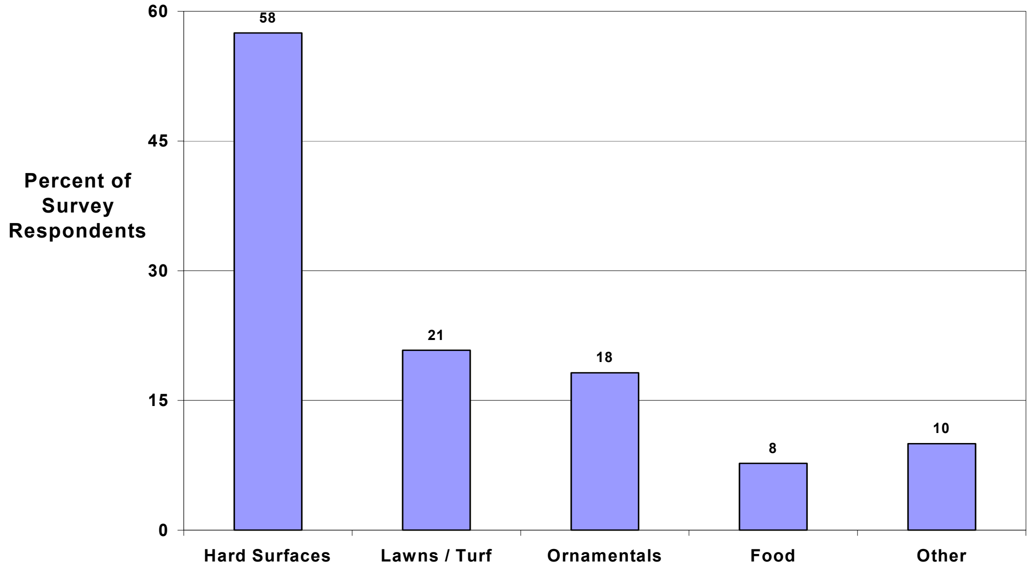

FIGURE 6.6
Sites Where Bay Area Residents Apply Over-the-Counter Pesticides

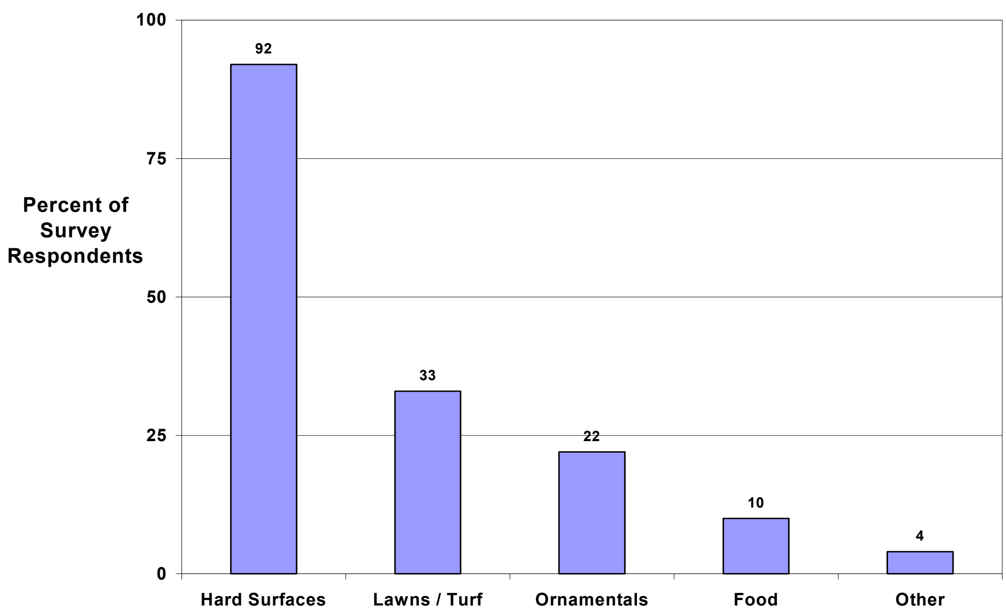

FIGURE 6.7
Sites Where Professionals Apply Pesticides for Bay Area Residents

In addition to impervious surfaces, Figure 6.6 indicates that many homeowners also apply pesticides to plants and soil. Professional landscape maintenance gardeners apply diazinon to plants and soil, too. Although runoff from landscaped areas may not be as great as runoff from impervious surfaces, as much as 1% of diazinon applied to turf was found to run off (Evans et al. 1998). Therefore, pesticide applications to plants and soil may also pose water quality concerns.

Target Pests

Pesticide applications correlate with seasonal pest management challenges. Pest management literature and outreach programs are often organized by target pest (e.g., ants, fleas, grubs, and other pests), not by pesticide. The target pest determines the available pesticides, product formulations, application sites, and necessary application techniques. In turn, these factors determine the potential for surface water discharges. As shown in Figure 6.8, about 46% of Bay Area residents who apply pesticides do so to manage ants. As shown in Figure 6.9, about 60% of Bay Area residents who hire pest management professionals do so to manage ants (UC IPM 2003). These results mirror those of the Castro Valley survey, where more respondents reported ant problems than any other pest problem (ACFCWCD 1997). Ant-related applications pick up during the rainy season (i.e., winter) when ants are more likely to come indoors (Palo Alto 1996). Landscaping-related pesticide applications peak in July and are lowest in January. Structural pest control applications are similarly low in January, although the seasonal fluctuation is considerably less (ACFCWCD 1997).

PRIMARY OPPORTUNITIES TO REDUCE PESTICIDE DISCHARGES

According to Figure 6.3, until recently, most diazinon used in urban areas was sold over-the-counter or to structural pest control professionals. As discussed in Section 3, “Pesticide Use Trends,” various pesticide alternatives are now replacing diazinon for these same uses. Combined with the information above regarding pesticide formulations, application sites, and target pests, some prime opportunities to reduce pesticide discharges to urban creeks become clear.

- Over-the-counter pesticide use threatens water quality because (1) substantial quantities of pesticides are sold over-the-counter, (2) residential consumers apply over-the-counter products to impervious surfaces, (3) private citizens receive relatively little regulatory oversight after pesticides are sold over-the-counter, and (4) private citizens are known to sometimes handle pesticides improperly. Efforts focusing on private residential pesticide use could reduce pesticide discharges.

- Structural pest control pesticide use threatens water quality because (1) substantial quantities of pesticides are applied; (2) structural pest control professionals apply pesticides to impervious surfaces; (3) pesticide formulations favored by pest control professionals exhibit relatively high runoff potentials; and (4) pesticide use trends indicate that use of many pesticides applied primarily for structural pest control is

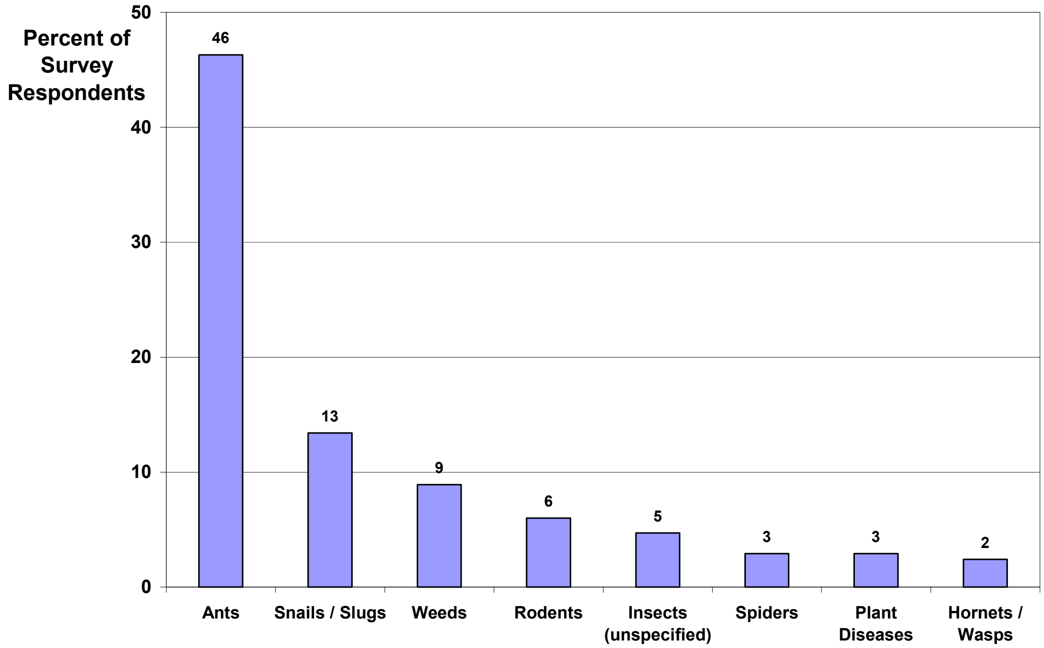

FIGURE 6.8
Pest Problems for Which Bay Area Residents Apply Pesticides

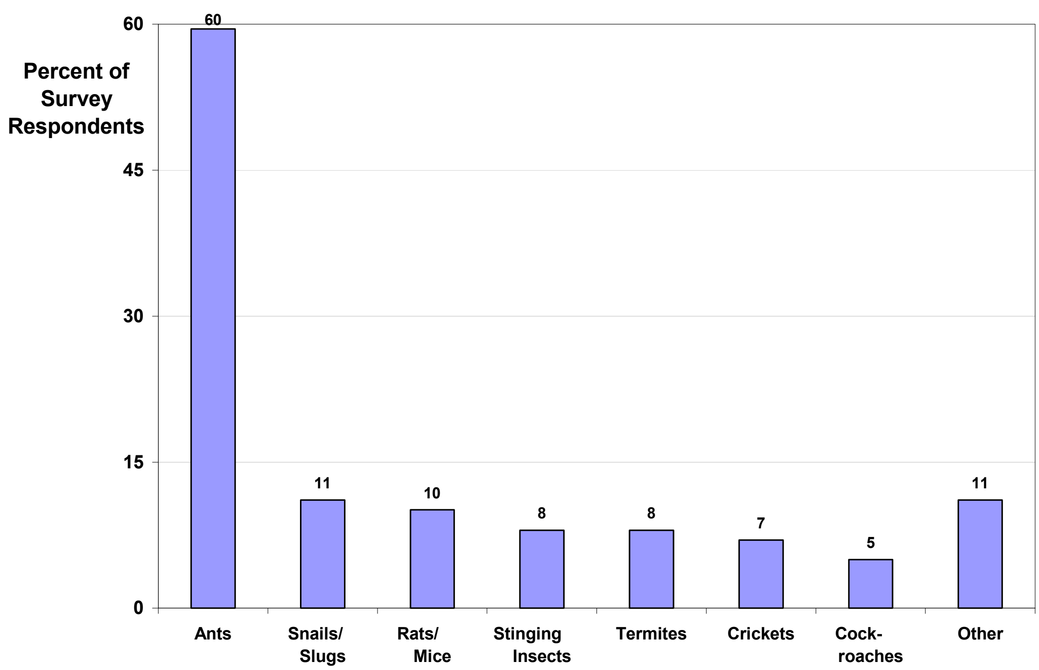

FIGURE 6.9
Pest Problems for Which Bay Area Residents Hire Professionals

increasing. Efforts focusing on outdoor pesticide applications for structural pest control could substantially reduce pesticide discharges.

- Whether private citizens or professionals apply pesticides, their primary pest problem is usually ants. Therefore, changing pest management behavior related to this one pest problem could substantially reduce pesticide discharges to Bay Area urban creeks.

KEY POINTS

- Pesticides enter urban creeks primarily through urban runoff.
- Runoff contains pesticides as a result of pesticides being manufactured, formulated into products, and sold through distributors and retailers to businesses and individuals who apply them for structural pest control, landscape maintenance, agricultural, and other pest management purposes.
- Pesticide use by structural pest control professionals and use of products sold over-the-counter are among the greatest contributors to the pesticides in urban runoff.
- In the Bay Area, pesticides are most often used to control ants.

7. NUMERIC TARGETS

This section identifies numeric targets that interpret the Basin Plan's narrative objectives (quoted in Section 5, "Project Description") in terms of quantitatively measurable water quality parameters. The TMDL process calls for the development of numeric targets that, if achieved, ensure attainment of water quality standards (USEPA 2000d). Numeric targets appropriate for pesticide-related toxicity and diazinon concentrations are identified below for Bay Area urban creeks.

TOXICITY TARGETS

To protect aquatic life in Bay Area urban creeks, pesticide concentrations must be controlled such that no toxicity occurs. As discussed in Section 3, "Pesticide Use Trends," changing pesticide use trends may increase the potential for any number of pesticides to contribute to toxicity in urban creeks. Pesticide-specific water quality criteria are unavailable for most pesticides of concern, and diazinon replacements are likely to occur as pollutant mixtures. Measures of toxicity incorporate the combined effects of chemical mixtures (e.g., mixtures of pesticides with similar toxic effects). Therefore, numeric toxicity targets are appropriate to ensure that the environmental benefits of the U.S. Environmental Protection Agency's actions to phase out diazinon in urban areas are not offset by new sources of toxicity.

Toxicity Target Development

Although there are several ways to measure the health of an aquatic ecosystem (e.g., studying indicator organisms, species diversity, population density, or growth anomalies, or conducting standard toxicity tests), the Basin Plan specifically refers to toxicity test methods developed as part of the Effluent Toxicity Characterization Program (SFBRWQCB 1991). The U.S. Environmental Protection Agency has promulgated similar Whole Effluent Toxicity test methods (USEPA 2002g,h). The Basin Plan discusses these test methods in the context of point sources, such as wastewater treatment plants. This test method discussion constitutes the most direct guidance the Basin Plan offers regarding the measurement of toxicity and the interpretation of the narrative toxicity objective. The Basin Plan does not rule out other options for evaluating toxicity, but it does not discuss such alternatives in detail.

The standard freshwater toxicity tests involve the three species listed in Table 7.1. These test organisms are exposed to water samples for a specific duration and their responses are compared to those of control organisms exposed to control water. A sample is considered toxic if it results in a response that differs significantly from the response of control organisms. Although the range of biological effects these tests evaluate is limited, the tests reliably predict ecological responses (USEPA 1991a; USEPA 1999). A similar toxicity test for freshwater sediment involves *Hyalella azteca* or *Chironomus*

TABLE 7.1
Water Column Toxicity Test Protocols

Species	Common Name	Acute Exposure Duration	Biological Endpoint Assessed	Chronic Exposure Duration	Biological Endpoint Assessed
Pimephales promelas	fathead minnow	1, 2, or 4 days	Survival	7 days	Survival & growth
Ceriodaphnia dubia	water flea	1, 2, or 4 days	Survival	6-8 days	Survival & reproduction
Selenastrum capricornutum	green algae			4 days	Cell division

Sources: SFBRWQCB 1991; USEPA 2002g.

tentans, which are both sediment-dwelling invertebrates. These tests last 10 days and evaluate survival and growth (USEPA 2000g).

Rather than explicitly defining numeric objectives for toxicity, the Basin Plan allows for evaluations to be made on a case-by-case basis. The U.S. Environmental Protection Agency has developed guidance for incorporating Whole Effluent Toxicity tests into National Pollutant Discharge Elimination System permits (USEPA 1996). This guidance relies on the concept of “toxic units” to derive permit limits. A toxic unit is a measure of toxicity that behaves like a concentration—it varies proportionally with the toxicity of a sample. The numeric targets proposed below are based on a similar approach, with important modifications to accommodate some practical considerations.

Acute Toxicity. For purposes of this report, toxic units are defined for acute toxicity tests (typically involving shorter duration exposures and more life-critical biological endpoints, such as survival) in terms of the “no observed adverse effect concentration” (NOAEC). This concentration is the highest tested concentration of sample that causes no observable adverse effect to exposed organisms. For the acute toxicity tests discussed above, an adverse effect refers to mortality. Figure 7.1 illustrates the NOAEC concept. “No observable adverse effect” can be interpreted to mean no effect that is statistically significant. The NOAEC is a concentration expressed as a percentage of a sample in a test container (an undiluted sample has a concentration of 100%). For example, if a series of tests were conducted using 25%, 50%, and 100% sample water and significant toxic effects were observed at 100% but not at 25% or 50%, then the NOAEC would be 50%.

For purposes of this strategy, acute toxic units (TU_a) are defined as follows:

$$TU_a = 100 / NOAEC$$

In the example above, since the NOAEC would be 50%, then the sample would have 2 TU_a.

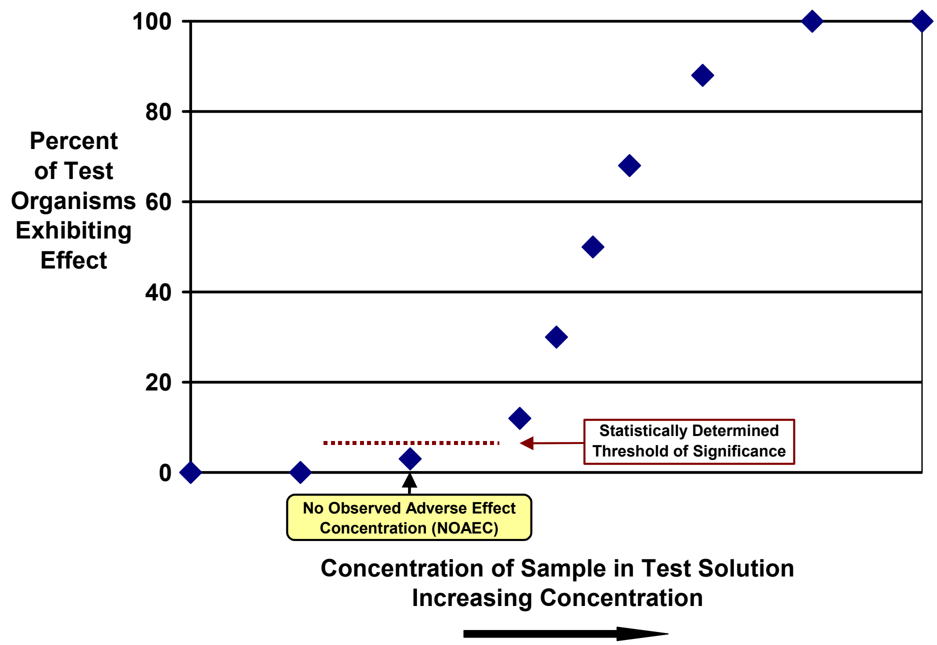

FIGURE 7.1
Conceptual Illustration of
"No Observed Adverse Effects Concentration"

Chronic Toxicity. Toxic units for chronic toxicity tests (typically involving longer duration exposures and sub-lethal effects) are defined in terms of the "no observed effect concentration" (NOEC), which is analogous to the NOAEC for acute effects. The chronic toxicity tests listed in Table 7.1 assess survival, growth, reproduction, and cell division. The observed effects need not be adverse to the test organisms (e.g., they could include increased growth or cell division).

For purposes of this strategy, chronic toxic units (TU_c) are defined as follows:

$$TU_c = 100 / NOEC$$

Toxicity Targets. The Basin Plan's narrative objectives do not allow any acute or chronic toxicity. According to the Basin Plan, no toxic effects should be observable in undiluted samples collected from Bay Area waters. This condition corresponds to the NOAEC being at least 100% or no more than 1.0 TU_a, and the NOEC being at least 100% or no more than 1.0 TU_c. Therefore, the proposed numeric toxicity targets are as follows.

> *There shall be no pesticide-related acute or chronic toxicity in urban creeks in excess of 1.0 TU_a or 1.0 TU_c.*

If aquatic life is to be protected at all creek locations, each urban creek must meet these proposed toxicity targets at all locations, including those near storm drain outfalls where urban runoff enters receiving waters. Toxicity reductions are needed to meet these targets in Bay Area urban creeks. As discussed in Section 2, “Water Quality Conditions,” toxicity was frequently observed in urban creeks during the 1990s (BASMAA 1996). More recently, toxicity has been observed less frequently in urban creek water, but it still occurs (SFBRWQCB 2005d). Instances of sediment toxicity are now being reported (Amweg et al. 2005b). To achieve the targets, the toxicity in urban creeks must be eliminated.

Practical Considerations

Various practical considerations must be taken into account in implementing the proposed toxicity targets.

Limited Endpoints. Together, the proposed toxicity targets are a numeric expression of the narrative objectives. Basing the toxicity targets on standard laboratory toxicity tests is not intended to limit the types of methods that can be used to evaluate toxicity and attainment of the narrative objectives. The toxicity tests for freshwater measure a limited number of toxic effects for a limited number of test species. For example, the *Ceriodaphnia dubia* test measures only mortality and reproduction. The test does not evaluate other possible sublethal endpoints for *Ceriodaphnia dubia*, nor does it address the full range of possible effects for other species. The Water Board may need to evaluate toxicity using other tools in specific circumstances.

Dilution Series. Determining a NOAEC (acute tests) or NOEC (chronic tests) requires conducting toxicity tests at multiple concentrations; however, testing multiple concentrations may not always be necessary to determine whether a sample exceeds the proposed targets. An undiluted sample that does not exhibit significant adverse effects when compared to control samples would meet the proposed targets. Further testing would only be needed if significant toxicity were observed. Testing at multiple concentrations would allow the magnitude of the observed toxicity to be measured.

For purposes of this strategy, an undiluted ambient water or sediment sample that does not exhibit an acute or chronic toxic effect that is significantly different from control samples on a statistical basis can be assumed to meet the relevant toxicity target.

Toxicity Not Caused by Pesticides. Not all toxic water samples necessarily contain pesticides. The water quality attainment strategy is intended to address pesticide-related toxicity and is not intended to address the full range of possible toxic pollutants in urban creeks. If the proposed toxicity targets were substantially and consistently exceeded, additional study (e.g., toxicity identification evaluations) could be warranted to determine the cause of the toxicity. If the cause were related to pesticides, management efforts intended to address pesticide-related toxicity could apply. Other management strategies targeted at other toxic chemicals may be necessary if the toxicity were found to be unrelated to pesticides. Such strategies are beyond the scope of this water quality attainment strategy.

DIAZINON CONCENTRATION TARGET

The proposed toxicity targets address potential interactions among whatever pesticides and other chemicals may be present in Bay Area urban creeks. However, due to potential challenges associated with determining the causes of toxicity, particularly if toxicity is caused by multiple factors, a diazinon concentration target may be useful in the short-term. The selection of multiple targets is consistent with National Research Council recommendations that chemical, biological, and physical criteria be used together to measure whether beneficial uses are achieved (NRC 2001).

Several possible methods are available for the development of a diazinon concentration target (CVRWQCB 2001a,b). Table 7.2 reviews the primary options and lists some of their advantages and disadvantages. Developing a concentration target using U.S. Environmental Protection Agency guidelines for deriving water quality criteria (USEPA 1985) appears to be the best approach because it relies on established guidelines, considers only data that meet minimum acceptability requirements, ensures that almost all organisms experience almost no mortality (a reasonable facsimile of the Basin Plan objectives), protects known sensitive organisms, and accounts for effects of acute and chronic exposure. Numeric water quality objectives are often based on water quality criteria developed using the U.S. Environmental Protection Agency guidelines.

Application of the U.S. Environmental Protection Agency's guidelines results in two concentration-based criteria to protect aquatic life. One criterion relates to the effects of acute exposure, and one relates to the effects of chronic exposure. The acute criterion is a one-hour average not to be exceeded more than once every three years. The chronic criterion is a four-day average not to be exceeded more than once every three years. Using the U.S. Environmental Protection Agency guidelines, the acute criterion is derived from LC_{50} data (chemical concentrations lethal to 50% of test organism exposed for a given duration) representing numerous species of fish, other vertebrates, and invertebrates. Eight specific toxicity data requirements must be met. The computation estimates a concentration likely to have little or no acute effect on most species. The chronic criterion is derived from similar data using ratios observed between

TABLE 7.2
Methods for Deriving Numeric Concentration Targets for Diazinon

Method	Approach	Possible Target (ng/l)	Advantages and Disadvantages
Water Quality Criteria	Derive concentration intended to protect essentially all organisms by using toxicity data for sensitive species	100 - 160	• Relies on U.S. Environmental Protection Agency guidelines • Considers only data that meet minimum acceptability requirements • Ensures that almost all organisms experience almost no mortality • Protects known sensitive organisms • Accounts for effects of acute and chronic exposure
Single-Species Toxicity Tests	Determine concentration causing lethal or sublethal effects to one or more sensitive or indicator species (e.g., *Ceriodaphnia dubia*)	100 - 500	• Directly relates to standard toxicity test upon which impairment is based • May not protect all test species • May not adequately address effects of chronic exposure
Probabilistic Ecological Risk Assessment	Derive concentration protective of most species most of the time using toxicity data for a number of species and surface water quality monitoring data	200 – 4,000	• Requires an extensive database • Depends on the quality of available data (e.g., time and location of data collection and number of samples) • Does not typically account for effects of chronic exposure • Relies on concentrations acutely toxic to 50% of test organisms without translating values to protect a higher percentage of test organisms (inconsistent with the Basin Plan toxicity objective)
Microcosm and Mesocosm Studies	Study toxicological effects under quasi-natural conditions by using small and medium-scale experimental ecosystems	2,000 – 9,000	• Accounts for indirect ecological effects (e.g., effect on growth due to reduced food supply) • May inadequately mimic environmental conditions • May not protect all organisms, including those studied (available studies provide “lowest observed adverse effects concentration” but not “no observed adverse effects level”)

ng/l, nanograms per liter
Source: CVRWQCB 2001a,b; CDFG 2004.

concentrations known to cause acute effects (such as mortality) and concentrations known to result in chronic effects (such as impaired growth or reproduction).

The U.S. Environmental Protection Agency and the California Department of Fish and Game independently developed water quality criteria for diazinon following the U.S. Environmental Protection Agency's guidelines. (The U.S. Environmental Protection Agency criteria exist only in draft form.) Each made distinct assumptions that resulted in different criteria. The U.S. Environmental Protection Agency has proposed acute and chronic criteria of 100 ng/l for diazinon in freshwater (USEPA 2000e). In contrast, the California Department of Fish and Game developed an acute criterion of 80 ng/l and a chronic criterion of 50 ng/l (CDFG 2000b). The California Department of Fish and Game criteria are lower because the U.S. Environmental Protection Agency considered some different acute toxicity studies and did not rely on a particular chronic toxicity study (CDFG 2001). The differences between these sets of criteria are within the range of discretion provided by U.S. Environmental Protection Agency's guidelines (USEPA 2002f).

As a result of the discovery that a questionable study involving *Gammarus fasciatus* was included in the development of both sets of criteria, the California Department of Fish and Game revised its criteria. Its new acute criterion is 160 ng/l, and its new chronic criterion is 100 ng/l (CDFG 2004). (The U.S. Environmental Protection Agency may also revise its draft criteria because it relied on the same *Gammarus fasciatus* data.) These revised criteria are reasonable numeric targets for diazinon concentrations in Bay Area urban creeks. They are lower and potentially more protective than the other potential targets listed in Table 7.2 (except for those derived using the questionable *Gammarus fasciatus* study).

Though generally protective, the U.S. Environmental Protection Agency's guidance for developing water quality criteria does not necessarily account for all types of toxicity. Research concerning the sublethal effects of diazinon on salmon indicates that short-term exposures to diazinon concentrations of 300 ng/l can reduce levels of reproductive steroids in some fish (e.g., salmon) (Moore and Waring 1996). Exposures to diazinon concentrations of 1,000 ng/l can inhibit the ability of some fish to smell (Scholz et al. 2000), which could be detrimental to fish that rely on their sense of smell to avoid predation or to perform other critical behavioral functions. These adverse effects were not observed at 100 ng/l. Therefore, to provide an added measure of protection beyond the California Department of Fish and Game criteria of 160 ng/l, the proposed target reflects this no observed effects level:

> *The one-hour average concentration of diazinon in freshwater shall not exceed 100 ng/l.*

Water quality criteria are often expressed with both acute (one-hour average) values and chronic (four-day average) values. A four-day average target is not proposed because, based on the revised California Department of Fish and Game criteria, it would also be

100 ng/l and implementing a one-hour average target of 100 ng/l ensures that the four-day average would also not exceed 100 ng/l.

The diazinon concentration target is intended to protect all species and is derived from toxicity data for many different species. Therefore, it is lower than the LC_{50} for *Ceriodaphnia dubia*. Water containing only diazinon (not a mixture of toxic substances) can exceed the diazinon concentration target without exceeding the toxicity targets.

To protect aquatic life at all creek locations, each urban creek should meet the proposed diazinon concentration target at all locations, including those near storm drain outfalls, where urban runoff enters receiving waters. As discussed in Section 2, "Water Quality Conditions," diazinon concentrations in urban creeks frequently exceeded the targets during the 1990's (SWRCB et al. 1997; ACCWP and ACFCWCD 1997). More recently, diazinon is detected less frequently, but it is still found sometimes in urban creeks (SFBRWQCB 2005d). To achieve the target, diazinon concentrations in urban creeks must be reduced and maintained below 100 ng/l.

ANTIDEGRADATION

Numeric targets developed for TMDLs must be consistent with antidegradation policies. The Code of Federal Regulations (Title 40, §131.12) contains the federal antidegradation policy. State Water Resources Control Board Resolution 68-16 contains California's antidegradation policy. These antidegradation policies are intended to protect beneficial uses and the water quality necessary to sustain them. When water quality is sufficient to sustain beneficial uses, it cannot be lowered unless doing so is consistent with the maximum benefit to the citizens of California. Even then, water quality must sustain existing beneficial uses.

The proposed numeric targets are designed to implement the Basin Plan's narrative water quality objectives. They are essentially interpretations of the narrative objectives, which have already been established. To be consistent with the antidegradation policies, these targets, taken together, cannot be less stringent than the narrative objectives. The combination of the proposed targets is, in fact, at least as protective as the narrative objectives. Since at times toxicity and diazinon concentrations already exceed the narrative objective, meeting the targets would improve current water quality conditions. Therefore, the proposed targets are consistent with the antidegradation policies and the protection of water quality and beneficial uses.

KEY POINTS

- The proposed pesticide-related toxicity targets are 1.0 TU_a for acute toxicity and 1.0 TU_c for chronic toxicity, as determined through standard tests.
- The proposed diazinon concentration target is 100 ng/l (one-hour average).

- To protect aquatic life at all creek locations, each urban creek should meet the proposed targets at all locations, including those near storm drain outfalls where urban runoff enters receiving waters.
- The targets are consistent with state and federal antidegradation policies.

8. LINKAGE ANALYSIS

This section describes the links between the sources of pesticides in Bay Area urban creeks and the proposed targets. Section 7, "Numeric Targets," describes the links between the targets and the Basin Plan's narrative objectives. In this way, pesticide sources are linked to the Basin Plan objectives.

CONCEPTUAL MODEL

A conceptual model can represent the current understanding of the physical, chemical, and biological processes underlying pesticide behavior in the environment. Below, such a model frames a discussion of pesticide transport mechanisms to urban creeks and pesticide fate and effects.

Figure 8.1 illustrates the general path that pesticides follow from application sites to urban creeks. The initial release occurs during structural pest control, landscape maintenance, or other outdoor applications to soils, plants, or paved areas. The pesticide is then transported in surface runoff to storm drains during rain or irrigation events. Urban runoff containing pesticides is discharged into urban creeks at storm drain outfalls. As pesticides move from application sites to creek habitats, several processes affect pesticide concentrations in urban creeks. For many pesticides, the most important of these are degradation, evaporation and deposition, and sediment transport, as illustrated in Figure 8.2.

Degradation

Pesticides decompose through exposure to light, water, and microbes. The relative importance of these factors for each pesticide determines its environmental persistence. Pesticides that degrade primarily through light exposure degrade faster on exposed pavement than on shaded turf. Pesticides that degrade primarily through water exposure degrade quickly in moist environments, but more slowly on dry pavement. Pesticides that degrade primarily through microbial action degrade faster on soil and plant surfaces than on pavement (SFBRWQCB 2003a).

Microbial activity is often the major route of diazinon degradation. Diazinon half-lives in soil range from 2 to 6 weeks (CVRWQCB 1993; Glotfelty et al. 1990; USEPA 2000f). However, under conditions where microbial action is limited, the half-life may extend to 26 weeks or longer (CVRWQCB 1993). Because microbial activity is more limited on paved surfaces than soil or plant surfaces, diazinon may degrade more slowly there (USEPA 2000f).

Because of differences in study designs, comparing published degradation rates for different pesticides can be difficult or inappropriate. However, available information suggests that many pesticides, including most of the pyrethroids, degrade at rates roughly

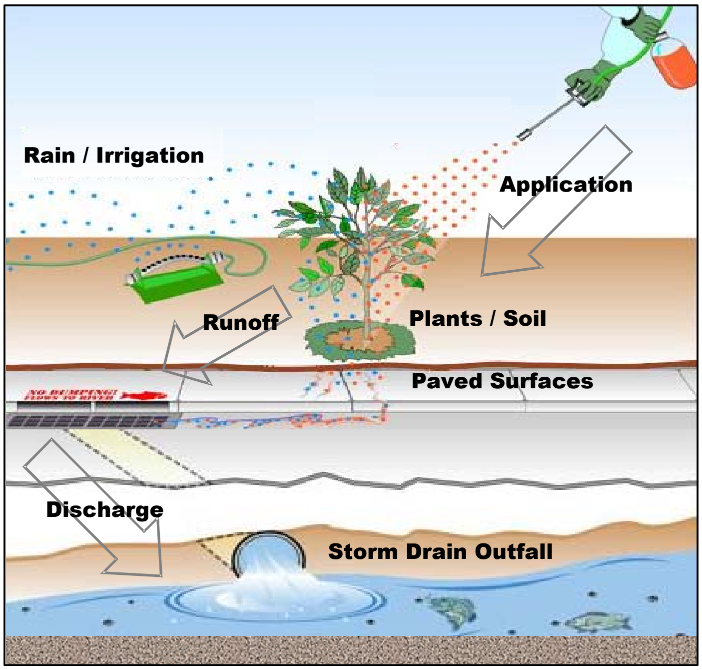

FIGURE 8.1
Primary Path of Pesticide Discharges to Urban Creeks

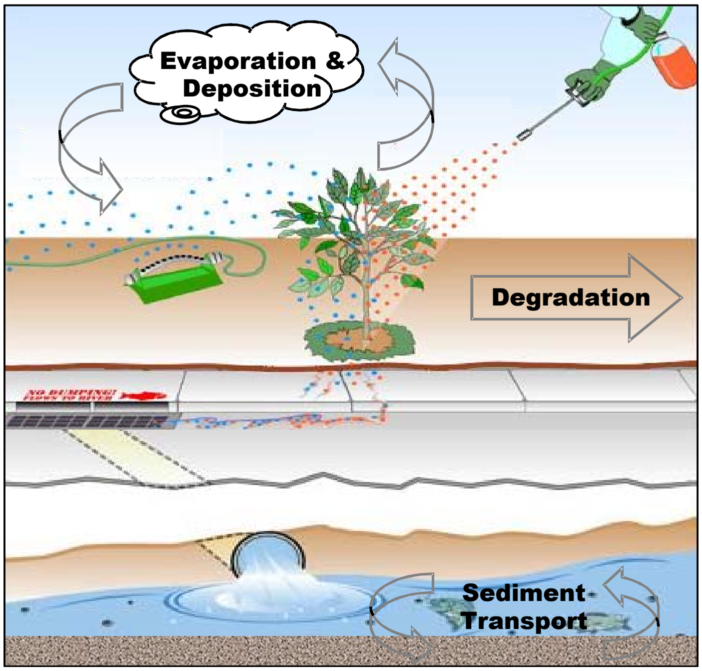

FIGURE 8.2
Important Pesticide Fate and Transport Processes

NOTE: Figures 8.1 and 8.2 are based on drawings from the University of California Statewide Integrated Pest Management Program.

comparable to diazinon. On paved surfaces, where relatively little microbial degradation occurs, pyrethroids decompose slowly enough that a significant fraction remains when rain or irrigation occurs (SFBRWQCB 2003a).

Relatively little is known about pesticide degradation in creek sediment, where conditions are substantially different than exposed surfaces and creek water. However, in one study, bifenthrin half-lives in sediment were about 60 weeks at 20°C, and permethrin half-lives in sediment were about 30 weeks (Gan et al. 2005). The persistence of these pesticides increased as the temperature decreased. At 4°C, bifenthrin half-lives were about 90 weeks. Permethrin half-lives were slightly longer, too, but still about 30 weeks. Bay Area creeks are typically colder than 20°C, but temperatures are rarely as low as 4°C. The presence of oxygen greatly affected the degradation rates. Half-lives were generally longer when oxygen was present.

Evaporation and Deposition

Atmospheric deposition can be an important conveyance for pesticides in the environment. The tendency for pesticides on dry surfaces to enter the atmosphere increases with higher vapor pressures. Table 8.1 compares vapor pressures for several pesticides. Diazinon's vapor pressure is relatively low (19×10^{-6} torr), and those of many other pesticides are lower still. The tendency for pesticides in soil or water to enter the atmosphere increases with higher Henry's Law constants. Table 8.1 compares Henry's Law constants for several pesticides. The Henry's Law constants for some pesticides, including most of the pyrethroids, are higher than that of diazinon.

Despite diazinon's relatively low vapor pressure and Henry's Law constant, it does evaporate from surfaces (Glotfelty et al. 1990), especially impervious surfaces (ACFCWCD 2001). Spray applications, in particular, result in aerosol losses to the atmosphere. When solutions are sprayed, some droplets remain airborne until they are deposited on nearby objects, such as buildings and roofs. Evaporation can occur from the surfaces of these droplets. In this way, a pesticide can move through the air from surface to surface. During a rain event, pesticides on objects above the ground are washed back to the ground onto plants, soils, and paved surfaces subject to runoff.

Pesticide evaporation and deposition occur in the Bay Area, but because of the limited volatility of airborne pesticides, they probably deposit locally, typically within the same watershed where applied, as is the case with diazinon (ACFCWCD 2001). Given the size of the Bay Area, in most cases pesticides transported to nearby watersheds probably simply trade places with pesticides from those watersheds. The potential for urban runoff to carry pesticides to an urban creek remains the same. Wind may carry some airborne pesticides beyond the Bay Area to the Central Valley, but the prevailing winds off the Pacific Ocean minimize pesticide transport from the Central Valley to the Bay Area.

TABLE 8.1
Physical Properties of Selected Pesticides

Pesticide	Solubility in Water (µg/kg)	Vapor Pressure (x 10^{-6} torr)	Henry's Law Constant (Pa-m^3/mol)	K_{ow}	K_{oc}
Carbaryl	110,000	1.2	0.00028	200	290
Diazinon	***60,000***	***19***	***0.072***	***2,000***	***1,500***
Imidacloprid	510,000	0.10	0.0000066[b]	3.7	130 to 310
Malathion	130,000	3.4	0.0011	500	1,200
Pyrethrins (type I)[a]	200	20	4.4[b]	790,000	39,000
Pyrethrins (type II)[a]	9,000	0.40	0.0022 [b]	20,000	5,200
Pyrethroids					
Bifenthrin	100	0.18	100	1,000,000	240,000
Cyfluthrin	20	0.033	0.096	890,000	31,000
Cypermethrin	4	0.0013	0.043	4,000,000	61,000
Deltamethrin	2	0.015	0.031[b]	270,000	46,000 to 1,600,000
Esfenvalerate	0.2	0.0015	0.042	10,000	5,300
Permethrin	6	0.022	0.19	1,300,000	39,000

K_{ow}, octanol-water partition coefficient
K_{oc}, organic carbon-water partition coefficient
[a] Type I and type II pyrethrins have slightly different chemical structures.
[b] The Agricultural Research Service database does not contain the Henry's Law constant for deltamethrin, imidacloprid, and pyrethrins. The value for deltamethrin is from Laskowski 2002. The others are estimated by dividing vapor pressure by solubility in water.
Source: SFBRWQCB 2003a; ARS 2005; Laskowski 2002

Sediment Transport

Sediment may serve as an important transport mechanism for pesticides in urban creeks and may also be an important sink. The tendency for a pesticide to adhere to particles or organic matter can be estimated from its octanol-water and organic carbon-water partition coefficients (K_{ow} and K_{oc}). Higher coefficients correspond to greater tendencies to adhere to particles and organic matter. Because diazinon tends to adhere to particles and organic matter, its coefficients are relatively high (far above one). Table 8.1 shows that, as a group, the pyrethroids adhere even more strongly to particles and organic matter. For this reason, they tend to wash off with particles and organic matter that wash off. Available data suggest that the wash-off potential of pyrethroids may be similar to that of diazinon (SFBRWQCB 2003a).

Pesticides that exhibit an affinity for particles may be deposited in the sediment of urban creeks. Pyrethroids discharged into surface water tend to disappear quickly from the water column (Laskowski 2002), but they can persist in sediment long enough to accumulate at toxic concentrations (Weston 2002; Weston et al. 2004; Amweg et al. 2005a,b; Gan et al. 2005). Sediment accumulation is particularly likely for bifenthrin and permethrin (SFBRWQCB 2003a). Sediment transport may contribute to pesticide mobility.

Depending on a pesticide's octanol-water partition coefficient (K_{ow}), some fraction may return from sediment to the water column. The fraction is lower when the partition coefficient is higher. The exchange between sediment and water may be an important process in stagnant pools and ditches that have high pesticide concentrations, or in creeks where water flows slowly over long stretches of pesticide-laden sediment (ACCWP 1999a). The importance of pesticide transport between sediment and surface water is not fully understood, but this process probably affects the potential for water column and sediment toxicity.

QUANTITATIVE TRANSPORT MODEL

Alameda County developed a quantitative transport model for the Castro Valley Creek watershed by modifying a version of the U.S. Environmental Protection Agency Storm Water Management Model (EPA-SWMM) (ACFCWCD 1999; Chen et al. undated). EPA-SWMM is designed to simulate pollutant loads, hydrology, and water quality in creeks. Alameda County's version of the model (Alameda-SWMM) simulates urban runoff and hydrology to estimate pollutant concentrations, as outlined in Figure 8.3. Alameda-SWMM incorporates the essential processes included in the conceptual model discussed above and predicts diazinon concentrations in Castro Valley Creek reasonably well. The Castro Valley Creek watershed is generally representative of urban Bay Area watersheds. Therefore, the conceptual model appears to adequately describe the fate and transport of pesticides in Bay Area urban creeks.

Alameda-SWMM simulates runoff over a two-year period. The model estimates the pesticide applications on soil and impervious surfaces at monthly intervals and reduces diazinon buildup through degradation. It tracks the amount of diazinon that washes off from various types of surfaces due to rain and irrigation. Runoff rates correspond to land uses and have values distinguishing urban (developed) and open space land uses.

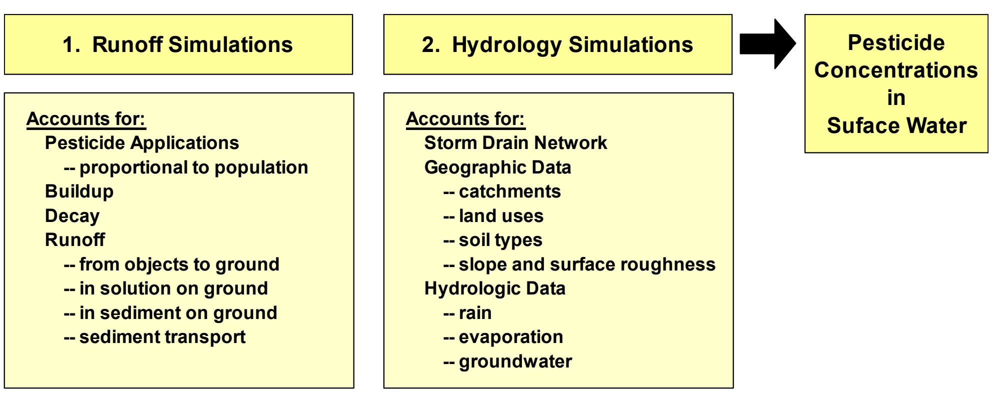

FIGURE 8.3
Quantitative Transport Model (Alameda SWMM)

The runoff simulation accounts for pollutant buildup on surfaces from air deposition, traffic, and human activity. For pesticides, human activity is the primary input. Alameda County assumed a per capita diazinon load of about 0.02 pounds per person. It estimated the population of each sub-catchment on the basis of data compiled by the Alameda County Community Development Agency and, combining this with the per capita application rate, estimated the amount of diazinon entering the watershed. The monthly load was adjusted to represent seasonal changes in application rates. Difficulty in estimating actual diazinon application rates contributes to uncertainty in the model results.

As a second operation, the Alameda-SWMM model simulates hydrologic processes, including rainfall, evaporation, surface discharge, and groundwater discharge. The hydrologic simulation is based on U.S. Geological Survey flow data collected in Castro Valley Creek. Combined with the diazinon loads estimated from the runoff simulation, the hydrologic components of the model estimate diazinon concentrations in Castro Valley Creek. Alameda County calibrated the model for Castro Valley Creek using watershed data for 1995-1996 and verified the model by comparing results with Castro Valley Creek data for 1996-1997 and 1999-2000.

To better match observed diazinon concentration data, Alameda County added a sediment transport module to simulate erosion, suspension, transport, and deposition of particles. Accounting for how diazinon adheres to sediment substantially improved the model's simulation of diazinon concentrations in water. Therefore, the most important factors affecting the model appear to be seasonal runoff, hydrologic flow, and sediment transport. The results of the quantitative model suggest that the conceptual model discussed above includes the processes most relevant to diazinon fate and transport from application sites to urban creeks.

ASSIMILATIVE CAPACITY

A TMDL can be expressed in terms of "mass per time," "toxicity," or any other appropriate measure, depending on the circumstances of the impairment (Title 40, Code of Federal Regulations, §130.2[i]). The proposed targets are expressed in terms of toxic units and diazinon concentration. If the toxicity and diazinon concentration in a creek were equal to the targets, the mass of pesticides in the urban creek would depend on its volume. The volume depends on flow, which varies continuously for each creek. Moreover, expressing the total maximum load in terms of "mass per time" is impractical, particularly because of the widely dispersed distribution of pesticide use throughout urban watersheds, the small amounts of pesticide discharges that can exceed the targets, and the episodic nature of pesticide discharges. Therefore, there is no fixed pesticide mass that any particular creek can assimilate. For these reasons, the assimilative capacity is best expressed in terms of toxicity and diazinon concentration, and is the same as the proposed targets.

KEY POINTS

- Pesticides are discharged to urban creeks after being applied outdoors and being washed away with urban runoff.
- Degradation, evaporation and deposition, and sediment transport are important pesticide fate and transport mechanisms.
- A quantitative transport model developed for a representative Bay Area watershed supports the conceptual model.
- Pesticide sources are linked to the proposed toxicity and diazinon concentration targets, which are linked to water quality standards.

9. ALLOCATIONS

This section allocates the assimilative capacity of the urban creeks (discussed in Section 8, "Linkage Analysis") among the pesticide sources (discussed in Section 6, "Source Assessment"). The allocation scheme ensures that diazinon and pesticide-related toxicity will not exceed the assimilative capacity of the urban creeks, thereby ensuring that water quality standards are met.

ALLOCATIONS

TMDL allocations are divided among "wasteload allocations" for point sources, "load allocations" for nonpoint sources, and any explicit "margin of safety." Essentially the only source of pesticides in Bay Area urban creeks is urban runoff, most of which is discharged from storm drains. Storm drains are point sources; therefore, they must receive wasteload allocations. Because no other significant sources exist, no other allocations are proposed. As discussed below, the analysis includes an implicit margin of safety; however, no explicit margin of safety is proposed because there is little uncertainty about the relationship between the allocations and water quality.

A TMDL can be expressed in terms of "mass per time," "toxicity," or any other appropriate measure (Title 40, Code of Federal Regulations, §130.2[i]); therefore, allocations can be also expressed in such terms (USEPA 2000d). The proposed targets and assimilative capacity (see Section 8, "Linkage Analysis") are expressed in terms of toxic units and diazinon concentration; therefore, the TMDL and proposed allocations are expressed in these terms. Expressing the TMDL and allocations in terms of toxic units and diazinon concentration is appropriate because there is no fixed pesticide mass that any particular creek can assimilate; the mass a creek can assimilate varies depending on its flow at any particular time.

When discharges from separate sources are combined, the concentration of their combined discharge does not equal the sum of their individual concentrations. Mass loads are additive, but concentrations are not. Because the TMDL is expressed in terms of toxicity and concentration, each source can receive the same allocation, which is equal to the numeric targets.

Numeric Targets = TMDL = Allocations

Urban Runoff

The allocations for this TMDL are assigned to urban runoff. While this proposed allocation scheme appears simple, assigning responsibility for urban runoff is complex. Urban runoff management agencies, listed in Table 9.1, represent communities that operate storm drains and are responsible for urban runoff discharges through National Pollutant Discharge Elimination System permits. The allocations also

TABLE 9.1
Bay Area Urban Runoff Management Agencies

Permit Type	Entity		NPDES Permit
Countywide [a]	Alameda Countywide Clean Water Program		CAS029831
	City of Alameda	City of Piedmont	
	City of Albany	City of Pleasanton	
	City of Berkeley	City of San Leandro	
	City of Dublin	City of Union City	
	City of Emeryville	Alameda County	
	City of Fremont	Alameda County Flood Control and Water Conservation District	
	City of Hayward		
	City of Livermore	Zone 7 of the Alameda County Flood Control and Water Conservation District	
	City of Newark		
	City of Oakland		
	Contra Costa Clean Water Program		CAS029912
	City of Clayton	City of Pinole	
	City of Concord	City of Pittsburg	
	Town of Danville	City of Pleasant Hill	
	City of El Cerrito	City of Richmond	
	City of Hercules	City of San Pablo	
	City of Lafayette	City of San Ramon	
	City of Martinez	City of Walnut Creek	
	Town of Moraga	Contra Costa County	
	City of Orinda		
	San Mateo County Stormwater Pollution Prevention Program		CAS029921
	Town of Atherton	City of Millbrae	
	City of Belmont	City of Pacifica	
	City of Brisbane	Town of Portola Valley	
	City of Burlingame	City of Redwood City	
	Town of Colma	City of San Bruno	
	City of Daly City	City of San Carlos	
	City of East Palo Alto	City of San Mateo	
	City of Foster City	City of South San Francisco	
	City of Half Moon Bay	Town of Woodside	
	Town of Hillsborough	San Mateo County	
	City of Menlo Park		
	Santa Clara Valley Urban Runoff Pollution Prevention Program		CAS029718
	City of Campbell	City of Palo Alto	
	City of Cupertino	City of San Jose	
	City of Los Altos	City of Santa Clara	
	Town of Los Altos Hills	City of Saratoga	
	Town of Los Gatos	City of Sunnyvale	
	City of Milpitas	Santa Clara County	
	City of Monte Sereno	Santa Clara Valley Water District	
	City of Mountain View		

Permit Type	Entity		NPDES Permit
Individual[b]	City of American Canyon		CAS612007
	Fairfield-Suisun Urban Runoff Management Program[c]		CAS612005
	City of Fairfield	City of Suisun	
	Vallejo Sanitation and Flood Control District		CAS612006
Statewide[d]	Alameda County	Napa County	CAS000004
	Port of Oakland	City of Calistoga	
	Marin County[e]	City of Napa	
	City of Belvedere	City of St. Helena	
	Town of Corte Madera	Town of Yountville	
	Town of Fairfax	Napa County	
	City of Larkspur	Solano County	
	City of Mill Valley	City of Benicia	
	City of Novato	Solano County	
	Town of Ross	Sonoma County	
	Town of San Anselmo	City of Petaluma	
	City of San Rafael	City of Sonoma	
	City of Sausalito	Sonoma County	
	Town of Tiburon	Sonoma County Water Agency	
	Marin County	San Francisco County	
		City and County of San Francisco[f]	
		Port of San Francisco	

[a] The Water Board has issued countywide permits for urban runoff management agencies in Alameda, Contra Costa, San Mateo, and Santa Clara counties.
[b] The Water Board has issued individual permits to American Canyon, Fairfield, Suisun City, and Vallejo. Fairfield and Suisun City discharge under a single permit.
[c] Fairfield and Suisun City discharge under a single permit.
[d] Smaller entities operate under a statewide permit from the State Water Resources Control Board. This list includes those already operating under the general permit and those that will definitely operate under the permit in the near future. It does not include all those anticipated to covered in the future.
[e] Although Marin County municipalities operate under the statewide permit, their programs are coordinated through the Marin County Stormwater Pollution Prevention Program.
[f] Only areas of San Francisco not served by the combined sewer system are subject to an urban runoff permit.

apply to construction, industrial, and institutional discharges to urban creeks subject to National Pollutant Discharge Elimination System permits, as well as California Department of Transportation [Caltrans] discharges to urban creeks.

Local communities do not have full control over pesticide applications within their jurisdictions (see Section 4, "Pesticide Oversight"). Many other parties also participate in urban pest management. Manufacturers make pesticide ingredients for formulators, who sell pesticide products to distributors and retailers, who in turn sell them to end users. All these parties bear some responsibility for the pesticides discharged in urban runoff.

Other Sources

Urban runoff is the primary source of pesticides to Bay Area urban creeks. Other sources appear to be negligible (see Section 6, "Source Assessment"). However, in the future, other sources could be discovered to discharge diazinon or other pesticides at concentrations that threaten water quality. If so, these sources could be given the same allocations given to urban runoff (the diazinon concentration and toxicity targets). Because the proposed targets are expressed in terms of concentration and toxicity instead of loads, additional sources can be identified and given these allocations without reducing the allocations assigned to urban runoff.

MARGIN OF SAFETY

A TMDL analysis involves uncertainty. To address this uncertainty, a TMDL is to include a margin of safety, which can be explicit or implicit or both. Reserving a specific allocation for the margin of safety would provide the margin of safety explicitly. Because the proposed targets are expressed in terms of diazinon concentration and toxicity instead of loads, this approach is unworkable. However, this analysis includes an implicit margin of safety by relying on a generally conservative approach. Moreover, the analysis involves relatively little uncertainty.

- ***Source Assessment.*** There is relatively little uncertainty in identifying urban runoff as the primary source of diazinon and pesticide-related toxicity in urban creeks. No other important sources exist. As discussed in Section 6, "Source Assessment," and Section 7, "Linkage Analysis," atmospheric deposition and sediment transport are relevant conveyances, but not sources of new discharges. Some agricultural pesticide use does occur within the Water Board's jurisdiction, but it is a negligible contributor. For example, in 2000, only 15% of the diazinon reportedly applied for agricultural purposes in the nine Bay Area counties was applied in the Water Board's jurisdiction, representing less than 2% of all the reported and unreported diazinon use in the Bay Area that year (CDPR 2001a; CDPR 2004; ACFCWCD 1997). As of 2003, roughly 93% of the pesticides applied in the nine Bay Area counties was for urban uses; only about 7% was for agricultural uses, and most of this occurred outside the Water Board's jurisdiction. All the pesticides of potential water quality concern discussed in Section 3, "Pesticide Use Trends," had less than 7% agricultural use, except for esfenvalerate (17%) and lambda cyhalothrin (71%) (TDC 2005b). The effect of agricultural esfenvalerate and lambda cyhalothrin use on Bay Area urban creeks is unknown. As new information becomes available, however, it can be addressed through adaptive implementation (see Section 11, "Monitoring and Adaptive Implementation").

- ***Numeric Targets.*** The proposed toxicity targets are conservative. Because 1.0 TU_a and 1.0 TU_c correspond to water samples statistically indistinguishable from non-toxic control samples, the toxicity targets cannot be expressed more strictly. The proposed diazinon concentration target is also conservative. It was selected, in part, because it is the lowest choice available. It is largely based on water quality criteria developed by the California Department of Fish and Game using U.S. Environmental Protection Agency guidelines intended to protect most aquatic organisms most of the time (USEPA 1985). The U.S. Environmental Protection Agency's approach is sufficiently conservative that criteria developed using the U.S. Environmental Protection Agency guidelines may be adopted as water quality objectives. Selecting a target below the California Department of Fish and Game acute criterion on the basis of the concentration where no sub-lethal effect has been reported provides an additional margin of safety. Moreover, the toxicity targets address shortcomings associated with the concentration target (e.g., not accounting for chemical interactions or potential toxicity associated with replacement pesticides).

- ***Linkage Analysis.*** The linkage between diazinon and pesticide-related toxicity sources (urban runoff) and the proposed targets (toxicity and diazinon concentration in urban creeks) is straightforward and not subject to substantial uncertainty.

The implementation plan outlined in Section 10, "Proposed Implementation Actions," and Section 11, "Monitoring and Adaptive Implementation," adds to the implicit margin of safety by incorporating an adaptive implementation approach to accommodate newly evolving information relevant to all aspects of the strategy.

SEASONAL VARIATIONS AND CRITICAL CONDITIONS

At times, the proposed targets are already met. At other times, the targets are exceeded. Weather and seasons affect creek flows and pesticide loads, concentrations, and toxicity. For example, in the 1990s, diazinon concentrations in Bay Area urban creeks declined during winter and increased in spring. A Castro Valley Creek study found that changes in diazinon concentrations in creek water followed the seasonal diazinon use pattern. Diazinon applications dropped during winter and rose in March, with the heaviest applications during summer and early fall. Pesticides now used in place of diazinon may follow a similar pattern if used to address the same types of pest problems.

Diazinon concentrations in urban runoff were greater when no substantial precipitation preceded a storm; therefore, diazinon levels were highest in urban runoff associated with the first winter storms. Variations in diazinon concentrations appeared to follow one of two patterns during storm events: (1) a peak concentration occurred early, followed by a substantial decline, or (2) elevated concentrations remained relatively consistent throughout a storm. The early peak concentrations corresponded to storms following periods without substantial precipitation. After storms ended, diazinon concentrations remained elevated, dropping by about one half within two days. During dry weather, discharges were sporadic; pulses from different individual sources occurred at different times. Water samples collected at the bottom of a watershed tended to average the effects of different pulses and their concentrations tended to be lower than the peaks observed upstream (ACCWP 1999b; ACCWP and ACFCWCD 1997).

Toxicity in urban creeks tends to be greater during storm events than during dry periods; however, the effects of such toxicity are transient, lasting only for the duration of the storm (SFBRWQCB 2005d). Although toxicity is typically lower during low runoff conditions, toxicity during these times is more critical because creek organisms may be exposed to such conditions for longer durations. Sediment toxicity is likely to vary much less by season. Sediment does move through urban creeks, but it does not flow like water.

Because aquatic life beneficial uses are present year-round, and because the Basin Plan's narrative objectives protect these uses year-round, the proposed targets and allocations are valid year-round. The pesticide mass loads implied by the toxicity and diazinon concentration targets vary by season, however, as creek conditions change.

KEY POINTS

- The total maximum load for each urban creek is allocated to the urban runoff that discharges into that creek.
- The allocation for each source is the same and equal to the numeric targets.
- While the allocation scheme may appear simple, many parties bear responsibility for pesticide discharges to creeks.
- The TMDL includes an implicit margin of safety and accounts for seasonal variations and critical conditions.

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Implementation Plan

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10. PROPOSED IMPLEMENTATION ACTIONS

This section describes an implementation plan for this water quality attainment strategy. It presents the plan's overarching strategy and goals, and lists proposed actions needed to ensure that dischargers meet the proposed allocations and Bay Area urban creeks meet the proposed targets. The plan calls for the involvement of all entities responsible for urban pesticide discharges.

IMPLEMENTATION OVERVIEW

The strategy is intended to eliminate and prevent pesticide-related toxicity in Bay Area urban creeks. As explained below, promoting integrated pest management is at the core of the strategy. Strategic goals focus on proactive regulation, education and outreach, and research and monitoring. Implementation will be managed adaptively to respond to new information as it becomes available.

Integrated Pest Management

Substituting the discharge of one pesticide for another could be counterproductive, particularly if the replacement pesticide causes toxicity. To address potential new risks resulting from the diazinon phase-out, this implementation plan's overarching strategy is to encourage pest management alternatives that do not threaten water quality and to discourage pesticide uses that do threaten water quality. One way to reduce the use of pesticides that threaten water quality is to practice integrated pest management. The University of California Statewide Integrated Pest Management Program defines this as follows (UC IPM 2001):

> *Integrated pest management…is 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 nontarget organisms, and the environment.*

The Bio-Integral Resource Center offers a similar definition (BIRC 2001):

> *Integrated pest management… is an approach to pest control that utilizes regular monitoring to determine if and when treatments are needed and*

> *employs physical, mechanical, cultural, biological and educational tactics to keep pest numbers low enough to prevent unacceptable damage or annoyance. Least-toxic chemical controls are used as a last resort.*

The U.S. Environmental Protection Agency Office of Pesticide Programs describes integrated pest management as follows (USEPA 2001):

> *The [integrated pest management] system consists of four steps: (1) set action thresholds; (2) monitor and identify pests; (3) prevent pests; and (4) control pests when necessary.*

Integrated pest management may involve the use of pesticides, but only when absolutely necessary. For purposes of this strategy, pest control methods selected to minimize the potential for pesticide-related toxicity in water and sediment are considered "less toxic pest control."

Integrated pest management techniques are effective. They can reduce the potential for pesticide discharges to occur, while minimizing the potential to create new risks by not necessarily replacing one toxic pesticide with another. As an illustrative example, Table 10.1 describes an integrated pest management approach for managing ants.
A survey of Bay Area residents confirmed that ants are the most frequently reported pest problem for which pesticides are applied (UC IPM 2003), and pesticides used to manage ants are often applied to impervious surfaces surrounding structures, where runoff to urban creeks is likely (CDPR 2001b).

TABLE 10.1
Integrated Pest Management Approach for Managing Ants

Action Step	Basic Concepts
1. Set Action Thresholds	Ants serve important ecological functions and generally pose no health risks. Outdoor ants are tolerable. Action may be required to control indoor ants.
2. Monitor and Identify Pests	Common Bay Area ants include Argentine ants and carpenter ants. These ants look different and require different management strategies. Individual "scouts" require a different management strategy than a major infestation.
3. Prevent Pests	Good hygiene practices (e.g., storing food in sealed containers and keeping areas clean and dry) are effective in preventing ant infestations. Entry points along walls, moldings, and baseboards, and in gaps around pipes and ducts, can be effectively blocked with petroleum jelly, tape, or caulk.
4. Control Pests When Necessary	Non-toxic ant control methods are effective. Individual "scouts" can be killed by hand. Ants along trails can be cleaned up with a vacuum or soapy water. Soap also washes away the chemical trails ants follow. As a last resort, pesticides can be used, but low toxicity baits are available that minimize pesticide use and confine the pesticide to a very small contained area.

Strategic Goals

This implementation plan focuses on three areas: (1) proactive regulation, (2) education and outreach, and (3) research and monitoring. The intent of proactive regulation is to prevent pollution by using existing regulatory tools to ensure that pesticides are not applied in a manner that results in discharges that threaten urban creek habitats. Education and outreach programs will focus on decreasing demand for pesticides that threaten water quality, while increasing awareness of alternatives that pose less water quality risk. Programs will increase both the demand for and supply of less toxic products and services. Research will fill existing information gaps, and monitoring will be used to measure implementation progress and success. The actions proposed below are intended to address these strategic goals.

Adaptive Implementation

Although available data are sufficient to support this report's analyses and implementation plan, an adaptive approach is proposed for implementation. This approach consists of a program of immediate actions to control pesticide discharges; a program of monitoring to determine progress toward meeting targets and the effectiveness of early actions; and a scheme to address critical information needs and adapt the plan as new information becomes available. Section 11, "Monitoring and Adaptive Implementation," describes the plan for obtaining, reviewing, and incorporating new information.

PROPOSED ACTIONS

To implement this strategy, the Water Board and many other entities will need to act. The U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, County Agricultural Commissioners, the California Department of Consumer Affairs (Structural Pest Control Board), and the Water Board will need to effectively use their regulatory authorities, described in Section 4, "Regulatory Oversight." Urban runoff management programs will need to reduce urban runoff discharges as much as possible. The University of California's Statewide Integrated Pest Management Program is poised to help in these efforts. In addition, the pesticide industry (manufacturers, formulators, distributors, and retailers) must bear some responsibility for water quality risks posed by the products they sell. Ultimately, private and professional pesticide users must change their attitudes and behavior to reduce pesticide discharges that threaten water quality. Water Board staff worked with many stakeholders to develop lists of actions (provided below) necessary to attain water quality standards.

Water Board Actions

The role of the Water Board is to encourage, monitor, and enforce implementation actions, and to lead by example. Table 10.2 lists proposed Water Board actions, grouped according to the three strategic focus areas listed above. Inherent in these proposed actions is that the Water Board will work with others responsible for pesticide use and oversight to encourage or require them to implement the actions proposed for them, as

TABLE 10.2
Water Board Actions

Focus	Actions
Proactive Regulation	WB-1. Track U.S. Environmental Protection Agency pesticide evaluation and registration activities as they relate to surface water quality and share monitoring and research data with U.S. Environmental Protection Agency.
	WB-2. When necessary, request that the U.S. Environmental Protection Agency coordinate implementation of the Federal Insecticide, Fungicide, and Rodenticide Act and the Clean Water Act.
	WB-3. Encourage the U.S. Environmental Protection Agency to fully address urban water quality concerns within its pesticide registration process.
	WB-4. Work with the California Department of Pesticide Regulation and the Structural Pest Control Board to ensure that pesticide applications result in discharges that comply with water quality standards.
	WB-5. Interpret water quality standards for the California Department of Pesticide Regulation and assemble available information (such as monitoring data) to assist the California Department of Pesticide Regulation and County Agricultural Commissioners in taking actions necessary to protect water quality.
	WB-6. Use authorities (e.g., through permits or waste discharge requirements) to require implementation of best management practices and control measures to minimize pesticide discharges to urban creeks.
Education and Outreach	WB-7. Encourage integrated pest management and less toxic pest management practices.
	WB-8. Encourage grant funding for activities likely to reduce pesticide discharges, promote less toxic pest management practices, or otherwise further the goals of this implementation plan.
	WB-9. Encourage pilot demonstration projects that show promise for reducing pesticide discharges throughout the Bay Area.
Research and Monitoring	WB-10. Promote and support studies to address critical data needs (see Section 11, "Monitoring and Adaptive Implementation").
	WB-11. Assist municipalities and others implementing the strategy by convening stakeholder forums to coordinate implementation.

listed in Tables 10.3 through 10.9. The Water Board can require certain implementation actions by urban runoff management agencies and similar entities responsible for urban runoff discharges through National Pollutant Discharge Elimination System permits.

The Water Board can encourage pesticide regulators to implement certain actions by making specific requests. When necessary, the Water Board can ask the U.S. Environmental Protection Agency to coordinate competing aspects of the Federal Insecticide, Fungicide, and Rodenticide Act and the Clean Water Act to ensure that use of registered pesticides does not result in violations of water quality standards. The Water Board can also ask the California Department of Pesticide Regulation to use its authorities. For example, the Water Board can identify the pesticides most likely to pose

TABLE 10.3
U.S. Environmental Protection Agency Actions

Focus	Actions	
Proactive Regulation	EPA-1.	Continue internal coordination efforts to ensure that pesticide applications comply with water quality standards and avoid water quality impairment (i.e., restrict uses or application practices to manage risks).
Education and Outreach	EPA-2.	Continue and enhance education and outreach programs to encourage integrated pest management and less toxic pest control.
Research and Monitoring	EPA-3.	Complete studies to address critical data needs (see Section 11, "Monitoring and Adaptive Implementation").

TABLE 10.4
California Department of Pesticide Regulation Actions

Focus	Actions	
Proactive Regulation	CDPR-1.	Work with the Water Board to identify pesticides applied in urban areas in such a manner that runoff does or could cause or contribute to water quality standard violations.
	CDPR-2.	Condition registrations, as appropriate, to require registrants to provide information necessary to determine the potential for their products to cause or contribute to water quality standard violations and to implement actions necessary to prevent violations.
	CDPR-3.	Continue and enhance efforts to evaluate the potential for registered pesticide products to cause or contribute to water quality standard violations (the California Department of Pesticide Regulation need not wait for the Water Board to evaluate potential water quality effects).
	CDPR-4.	Implement actions to eliminate pesticide-related water quality standard violations caused by registered pesticides.
	CDPR-5.	Implement actions to prevent potential pesticide-related water quality standard violations before they occur.
	CDPR-6.	Notify the U.S. Environmental Protection Agency of potential deficiencies in product labels for products that threaten water quality.
Education and Outreach	CDPR-7.	Continue and enhance education and outreach programs to encourage integrated pest management and less toxic pest control (work with County Agricultural Commissioners, urban runoff management agencies, and the University of California Statewide Integrated Pest Management Program to coordinate activities).
	CDPR-8.	Continue and enhance efforts to prevent the introduction of new exotic pests to the Bay Area.
Research and Monitoring	CDPR-9.	Complete studies to address critical data needs (see Section 11, "Monitoring and Adaptive Implementation").

TABLE 10.5
County Agricultural Commissioners Actions

Focus	Actions
Proactive Regulation	CAC-1. Continue and enhance enforcement related to illegal sale or use of pesticides, including pesticides sold over-the-counter.
	CAC-2. Continue to enforce the phase out of diazinon products and any new regulations affecting pesticide applications and their water quality risks.
	CAC-3. Continue and enhance efforts to prevent the introduction of new exotic pests to the Bay Area. (Exotic pests, such as red imported fire ants, can pose public health concerns if they reach the Bay Area and can result in increased pesticide use.)
Education and Outreach	CAC-4. Provide outreach and training to pest control licensees regarding water quality issues as part of pest control business license registration and inspection programs.
	CAC-5. Work with the California Department of Pesticide Regulation, urban runoff management agencies, and the University of California Statewide Integrated Pest Management Program to coordinate education and outreach programs to minimize pesticide discharges.

TABLE 10.6
California Department of Consumer Affairs Actions

Focus	Actions
Proactive Regulation	CDCA-1. Through licensing and other authorities, work to ensure that structural pest control practices result in discharges that comply with water quality standards.
	CDCA-2. Work to develop a mechanism through which consumers can determine which structural pest control providers offer services most likely to protect water quality.
Education and Outreach	CDCA-3. Work to enhance initial and continuing integrated pest management training for structural pest control licensees.

water quality risks, list information needed to evaluate potential water quality risks, share available pesticide concentration and toxicity data, and when appropriate, request that the California Department of Pesticide Regulation use its authorities to obtain necessary information from pesticide registrants. The Water Board can require any state or local agency to investigate technical factors involved in water quality control, as long as the cost of the study bears a reasonable relationship to its need and benefits (Water Code §13225[c]). After obtaining any needed information, the Water Board can work with the California Department of Pesticide Regulation and others to address any pesticides that potentially threaten water quality in urban creeks.

TABLE 10.7
University of California
Statewide Integrated Pest Management Program Actions

Focus	Actions
Education and Outreach	UCIPM-1. Continue and enhance educational efforts targeting urban pesticide users to promote integrated pest management and less toxic pest management practices.
	UCIPM-2. Continue to encourage and support efforts to identify and improve new less toxic pest management strategies for the urban environment.
	UCIPM-3. Continue to serve as a resource for information on alternative pest management practices that protect water quality and develop publications others can use to support outreach activities.
	UCIPM-4. Continue to train University of California Master Gardeners to help disseminate information about integrated pest management and pest management alternatives that protect water quality.
	UCIPM-5. Work with the California Department of Pesticide Regulation, County Agricultural Commissioners, and urban runoff management agencies to coordinate education and outreach programs to minimize pesticide discharges.

TABLE 10.8
Actions by Private Entities

Entity	Actions
Pesticide Manufacturers and Formulators	PRIV-1. Minimize potential pesticide discharges by developing and marketing products designed to avoid discharges that exceed water quality standards. (Many manufacturers successfully market such products.)
	PRIV-2. Undertake studies to address critical data needs (see Section 11, "Monitoring and Adaptive Implementation").
Pesticide Distributors and Retailers	PRIV-3. Offer point-of-sale information on less toxic alternatives.
	PRIV-4. Offer and promote less toxic alternatives to customers.
Pest Control Advisors *	PRIV-5. Recommend integrated pest management strategies so pesticides that could threaten water quality are used only as a last resort.
Pesticide Users	PRIV-6. Adopt integrated pest management and less toxic pest control techniques so pesticide applications do not contribute to pesticide runoff and toxicity in urban creeks.

* Although pest control advisors do not work at residential sites, they do recommend pest management actions for such "agricultural" sites as golf courses.

TABLE 10.9
Urban Runoff Management Agency Actions*

Focus	Actions	
General	URMA-1.	Reduce reliance on pesticides that threaten water quality by adopting and implementing policies, procedures, or ordinances that minimize the use of pesticides that threaten water quality in the discharger's operations and on the discharger's property.
	URMA-2.	Track progress by periodically reviewing the discharger's pesticide use and pesticide use by its hired contractors.
	URMA-3.	Train the discharger's employees to use integrated pest management techniques and require that they rigorously adhere to integrated pest management practices.
	URMA-4.	Require the discharger's contractors to practice integrated pest management.
	URMA-5.	Study the effectiveness of the control measures implemented, evaluate attainment of the targets, identify effective actions to be taken in the future, and report conclusions to the Water Board.
Education and Outreach	URMA-6.	Undertake targeted outreach programs to encourage communities within a discharger's jurisdiction to reduce their reliance on pesticides that threaten water quality, focusing efforts on those most likely to use pesticides that threaten water quality.
	URMA-7.	Work with the California Department of Pesticide Regulation, County Agricultural Commissioners, and the University of California Statewide Integrated Pest Management Program to coordinate education and outreach programs to minimize pesticide discharges.
	URMA-8.	Encourage public and private landscape irrigation management that minimizes pesticide runoff.
	URMA-9.	Facilitate appropriate pesticide waste disposal, and conduct education and outreach to promote appropriate disposal.
Research and Monitoring	URMA-10.	Monitor diazinon and other pesticides discharged in urban runoff that pose potential water quality threats to urban creeks; monitor toxicity in both water and sediment; and implement alternative monitoring mechanisms, if appropriate, to indirectly evaluate water quality as described below (see Section 11, "Monitoring and Adaptive Implementation").
	URMA-11.	Disseminate monitoring data to appropriate regulatory agencies.
	URMA-12.	Contribute to studies to address critical data needs (see Section 11, "Monitoring and Adaptive Implementation").
Proactive Regulation	URMA-13.	Track U.S. Environmental Protection Agency pesticide evaluation and registration activities as they relate to surface water quality and, when necessary, encourage the U.S. Environmental Protection Agency to coordinate implementation of the Federal Insecticide, Fungicide, and Rodenticide Act and the Federal Clean Water Act and to accommodate water quality concerns within its pesticide registration process.
	URMA-14.	Assemble and submit information (such as monitoring data) as needed to assist the California Department of Pesticide Regulation in ensuring that Bay Area pesticide applications comply with water quality standards.
	URMA-15.	Report violations of pesticide regulations (e.g., illegal handing) to County Agricultural Commissioners.

* These actions also apply to similar entities. Specifically, the "general" and "education and outreach" actions listed above apply to industrial, construction, and California Department of Transportation facilities. The monitoring requirements also apply to California Department of Transportation facilities as appropriate. All the actions apply to large institutions (e.g., universities and military installations).

Actions by Others

Tables 10.3 through 10.9 list actions proposed for others. They involve enhancements to existing activities and new efforts. Implementing the actions assigned to the U.S. Environmental Protection Agency (Table 10.3), the California Department of Pesticide Regulation (Table 10.4), County Agricultural Commissioners (Table 10.5), the California Department of Consumer Affairs (Table 10.6), and the University of California Statewide Integrated Pest Management Program (Table 10.7) will require inter-agency cooperation. Water Board staff proposes to encourage pesticide manufacturers, formulators, distributors, retailers, and pest control professionals to implement their actions (Table 10.8) voluntarily. Water Board staff will collaborate with the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and County Agricultural Commissioners to track their actions and those of the private sector.

The Water Board can require urban runoff management agencies and similar entities responsible for controlling urban runoff to undertake the actions in Table 10.9 pursuant to National Pollutant Discharge Elimination System permits. These permits require implementation of best management practices and control measures. Although municipal urban runoff management agencies do not have direct authority to regulate pesticide applications, they can implement a number of actions, as shown in Figure 10.1. Many

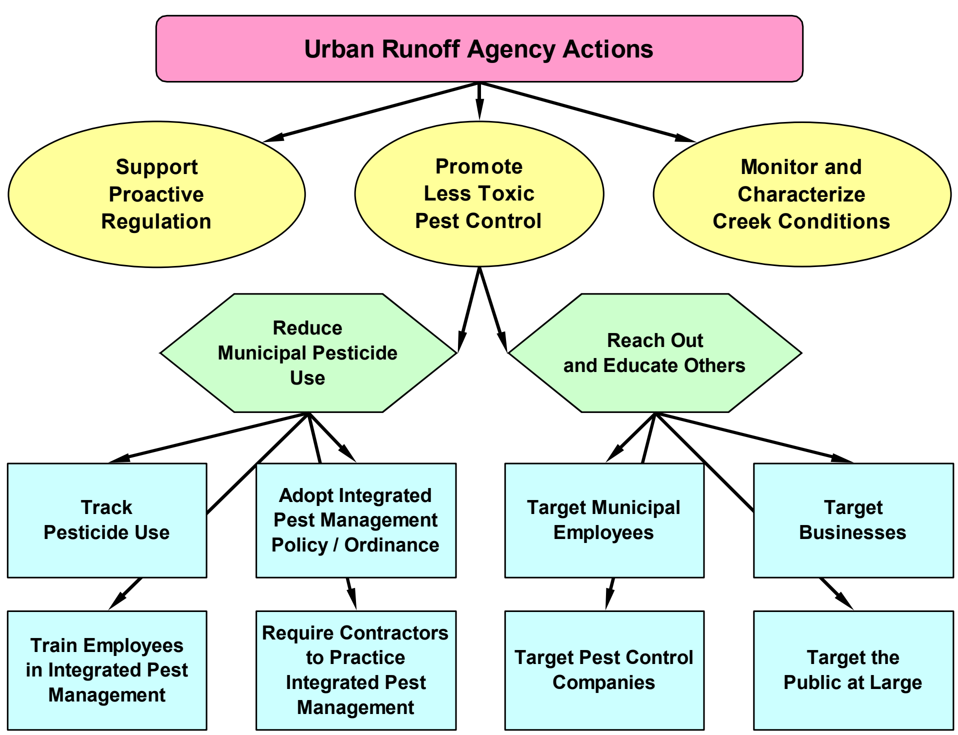

FIGURE 10.1
Urban Runoff Management Agency Actions

municipalities are already implementing these actions, as described in Section 12, "Early Implementation." Urban runoff management agencies' and similar entities' respective responsibilities for addressing the allocations and targets can be satisfied by implementing the actions listed in Table 10.9. Permit requirements can be based on frequently updated assessments of control measures intended to reduce pesticides in urban runoff to the maximum extent practicable, consistent with the Basin Plan section in Chapter 4 titled "Surface Water Protection and Management—Point Source Control - Stormwater Discharges."

Collaboration Within the California Environmental Protection Agency

As sister agencies within the California Environmental Protection Agency, the Water Board and the California Department of Pesticide Regulation need to coordinate pesticide and water quality regulation to prevent pesticide runoff that exceeds water quality standards. To this end, the following process is proposed, as illustrated in Figure 10.2.

Water Board will, after consulting with the California Department of Pesticide Regulation, implement the following actions:

- Gather and review available information to identify pesticides most likely to run off into urban creeks and cause or contribute to water quality standard violations;
- Identify evaluation criteria that can be used to discern whether water quality standards are met (e.g., water quality objectives, targets, monitoring benchmarks, or other criteria);
- Evaluate available information to determine whether water quality standards are met and, if so, whether circumstances suggest that future violations are likely; and
- Notify the California Department of Pesticide Regulation and County Agricultural Commissioners if water quality standard violations exist or are likely to exist in the future due to pesticide discharges, thereby enabling these agencies to implement appropriate actions and assisting them in ensuring that their regulatory programs adequately protect water quality.

In consultation with the Water Board, the California Department of Pesticide Regulation will implement the following actions:

- When available information is insufficient to conclude whether water quality standards are met, work with the Water Board to identify information needed to evaluate the potential for pesticide discharges to cause or contribute to water quality standard violations;
- Obtain information necessary to determine whether water quality standards are or are likely to be met from pesticide product registrants, the U.S. Environmental Protection Agency, and other sources (conservative [i.e., protective] assumptions may be used to fill information gaps);
- Evaluate whether water quality standards are likely to be met (e.g., consider pesticide use, toxicity, application sites and techniques, runoff potential, and environmental

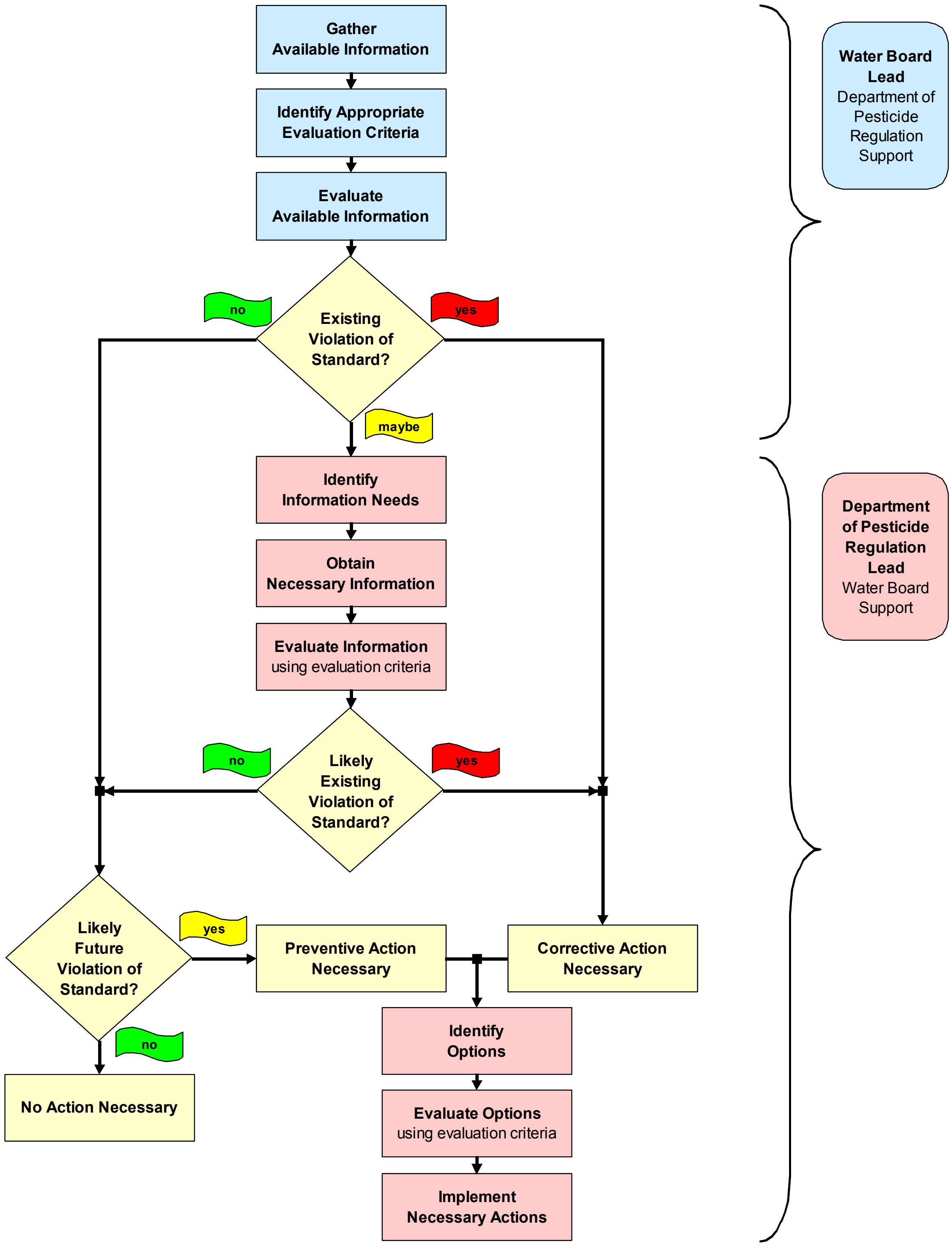

FIGURE 10.2
Collaboration Within the California Environmental Protection Agency

persistence; estimate foreseeable water and sediment pesticide concentrations; and consider Water Board evaluation criteria);

- When pesticide discharges are or are likely to cause or contribute to water quality standard violations, identify and evaluate possible corrective actions (using the Water Board's evaluation criteria) and implement those needed to ensure that water quality standards will be met; and
- When available information suggests that pesticide discharges appear likely to cause or contribute to water quality standard violations in the future (assuming standards are currently met), identify and evaluate possible preventive actions and, commensurate with the weight of the evidence, implement those actions needed to ensure that water quality standards will be met.

Sometimes, a pesticide-by-pesticide approach may be counterproductive, particularly if existing pesticide problems are likely to be replaced by new pesticide problems. As appropriate, the California Department of Pesticide Regulation may evaluate several pesticides at once if related to a specific application method, application site of concern, or other shared factor.

Although this proposed process indicates that the Water Board will take the lead in identifying and evaluating available information to determine the potential for pesticide-related water quality standard violations, it does not suggest that the California Department of Pesticide Regulation will relinquish its responsibility to continuously evaluate the potential for pesticide products to threaten water quality. Likewise, although the process calls for the California Department of Pesticide Regulation to ensure that actions necessary for compliance with water quality standards are taken, the Water Board will continue to identify and evaluate available information to confirm that water quality standards are met.

During adaptive implementation reviews (see Section 11, "Monitoring and Adaptive Implementation"), the Water Board will consider the extent to which inter-agency collaboration is sufficient to address water quality concerns. If necessary, the Water Board will notify the California Department of Pesticide Regulation of deficiencies and could consider the need to use its own regulatory authorities to control pesticide discharges.

Implementation Schedule

Many entities are already implementing the proposed actions (see Section 12, "Early Implementation"). The remaining actions can be phased in as soon as this water quality attainment strategy is adopted. Actions that can be required through permits can be incorporated into the permits the next time the permits are updated (i.e., within five years of the effective date of the strategy). Water Board staff will encourage voluntary actions and inter-agency coordination immediately.

Implementing the proposed actions is expected to result in attainment of the proposed targets. Because the U.S. Environmental Protection Agency phased out essentially all urban diazinon uses at the end of 2004, the diazinon concentration targets are expected to be met within the next few years. Because available information indicates that some pesticides may now be causing sediment toxicity in Bay Area urban creeks (Amweg et al. 2005b), the toxicity targets may take longer to meet. The timeline will depend primarily on the effectiveness of inter-agency coordination efforts. Monitoring will continue, as described in Section 11, "Monitoring and Adaptive Management," to evaluate the extent to which diazinon replacements are causing urban creeks to exceed the toxicity targets.

KEY POINTS

- The overarching strategy for eliminating and preventing pesticide-related toxicity in Bay Area urban creeks is to encourage pest management alternatives that do not threaten water quality and to discourage the use of pesticides that run off and threaten water quality, which can best be accomplished through the application of integrated pest management techniques and the use of less toxic pest control methods.
- This implementation plan includes proposed actions that focus on proactive regulation, education and outreach, and research and monitoring.
- Many entities share responsibility for the pesticide-related toxicity problem, and many entities must share responsibility for implementing actions to solve the problem.
- The role of the Water Board is to encourage, monitor, and enforce implementation actions, and to lead by example.
- Water Board staff proposes that the Water Board work with others responsible for pesticide use and oversight to encourage or require them to implement the actions proposed for them.

11. MONITORING AND ADAPTIVE IMPLEMENTATION

This section describes monitoring needed to track progress in implementing the actions proposed in Section 10, "Proposed Implementation Actions," and in meeting the proposed toxicity and diazinon concentration targets. Monitoring data may also inform regulatory decisions that the U.S. Environmental Protection Agency and the California Department of Pesticide Regulation may undertake. An adaptive implementation strategy is proposed that will allow the Water Board to consider new information gathered through monitoring and other activities and respond appropriately.

MONITORING

Purpose and Goals

Municipal urban runoff permits require dischargers to characterize their discharges and receiving waters. This generally involves monitoring toxicity and specific pollutants, like diazinon, in storm drains and urban creeks. This monitoring responsibility is ongoing, but flexible. For example, diazinon monitoring will be needed to demonstrate that diazinon concentrations meet the proposed target, but when concentrations drop below the target (due to phasing out urban applications and other actions), such monitoring may no longer be needed. Because other pesticides will continue to be applied in urban areas, however, the need to monitor water and sediment toxicity will remain well after achieving the diazinon concentration target.

Monitoring must seek to answer the following questions:

- Is the diazinon concentration target being met?
- Are the toxicity targets being met?
- Is toxicity observed in urban creeks caused by a pesticide?
- Is urban runoff the source of any observed toxicity in urban creeks?
- How does observed pesticide-related toxicity in urban creeks (or pesticide concentrations contributing to such toxicity) vary in time and magnitude across urban creek watersheds, and what types of pest control practices contribute to such toxicity?
- Are actions already being taken to reduce pesticide discharges sufficient to meet the targets, and if not, what should be done differently?

Substantial exceedances of the toxicity target may trigger the need for Toxicity Identification Evaluations or other studies to determine the causes of the toxicity (unless the toxicity can be attributed to a specific pesticide based on other information). Knowing the chemical causes of pesticide-related toxicity could inform decisions about future implementation actions. Monitoring efforts may also produce evidence of toxicity caused by chemicals other than pesticides. Although such toxicity would likely warrant additional study and action, anticipating such action is beyond the scope of this water quality attainment strategy.

Program Design

In keeping with the proposed actions proposed in Section 10, "Proposed Implementation Actions," urban runoff management agencies will design and implement acceptable monitoring programs. Each agency will have a monitoring plan. Monitoring plans may be developed by individual urban runoff management agencies, jointly by two or more agencies acting in concert, or cooperatively through a regional approach. Monitoring program design will involve characterizing watersheds and selecting representative creeks, identifying sample locations and developing sampling plans, and selecting appropriate analytical tests. These facets of water quality monitoring are discussed below, followed by a discussion of some additional types of monitoring that are also needed. Monitoring activities will be consistent with the Water Board's Surface Water Ambient Monitoring Program protocols, and monitoring data will be comparable to Surface Water Ambient Monitoring Program data (SWRCB 2002; MLML 2005).

Watershed Characterization. The first step in monitoring program development will be to characterize the Bay Area's urban creek watersheds and select representative creeks for monitoring. Selected creeks will be chosen among those known to receive substantial urban runoff (i.e., urban land uses will dominate). Monitoring plans will identify the locations of the selected creeks and describe their characteristics, including land uses and beneficial uses. The selected creeks will allow the Water Board to extrapolate monitoring results and conclusions to urban creeks not selected for monitoring. Because the urban runoff management agencies will undertake various implementation actions at the county or city level (e.g., by countywide urban runoff management programs), success in eliminating pesticide discharges in one geographic area may not be duplicated in all others. Therefore, when considered together, the selected creeks will represent different Bay Area regions. Additional sampling will be undertaken to confirm the representativeness of the selected creeks.

Site Selection and Sample Collection. Monitoring plans will identify sampling sites for each selected creek. Because the numeric targets must be met at all urban creek locations, sites will be selected to represent the essential range of creek conditions, including conditions near storm drain outfalls. Urban runoff management agencies may wish to include reference creeks with non-urban upstream land uses to confirm that non-urban sources (e.g., parkland, agriculture, or grazing) do not cause or contribute to pesticide-related toxicity in urban creeks. They may also consider monitoring storm drain discharges as a conservative indicator of creek water quality or to identify specific pesticide sources within the urban watershed.

Sampling will need to occur during at least two flow regimes:

- during storms that produce substantial runoff to urban creeks (ideally including the "first flush"), and
- during the dry season.

Monitoring plans will specify the number of monitoring stations, their locations, the number of samples to be collected at each station under each flow regime, the types of samples (water and sediment), and the analyses to be undertaken with each sample. Sampling frequency, timing, and the number of samples will be adequate to answer the monitoring questions listed above and any others set forth in the monitoring plans.

Analytical Tests. Monitoring plans will specify the tests to be undertaken with each sample. Chemical and toxicity tests will be conducted with urban creek water and sediment, as appropriate. At a minimum, tests will measure the following:

- Water column toxicity (see Section 2, "Water Quality Conditions," for a description of the U.S. Environmental Protection Agency's three species test [USEPA 2002g,h]),
- Sediment toxicity (an available method measures growth and survival of *Hyallela azteca*, a sediment-dwelling invertebrate found in Bay Area creeks [USEPA 2000g]),
- Diazinon concentrations in water (until the diazinon concentration target is met consistently—various techniques are available [e.g., gas chromatography and enzyme-linked immunosorbent assays]; analytical reporting limits should be sufficient to measure concentrations at or below the proposed target), and
- Concentrations of other pesticides that pose potential water quality threats (including sediment quality threats), as feasible (possible constituents and methods will be determined after initial monitoring; tests will focus on pesticides that pose substantial toxicity risks and for which commercially viable analytical methods are available).

General water quality parameters should also be measured, such as pH, conductivity, dissolved oxygen, total organic carbon, suspended sediment, and water temperature. Monitoring plans will also specify the circumstances that will trigger studies to identify the chemical causes of toxicity (e.g., Toxicity Identification Evaluations) and the approach to be used to conduct such tests.

Additional Monitoring. Additional types of monitoring will support and optimize conventional water quality monitoring. For example, monitoring in a storm drain system or near applications sites may be useful in selecting creek sampling strategies because pesticide concentrations are easier to detect at conveyance points closer to pesticide sources. Furthermore, efforts to monitor parameters that can serve as surrogates or indicators of pesticide-related water quality conditions may moderate the need for more comprehensive water quality monitoring. While some toxicity and pollutant monitoring will always be necessary, extensive monitoring will be less important if other information is collected that can be used to evaluate the potential for toxicity or specific pollutants to occur in water. Alternative monitoring information can help focus water quality monitoring efforts and mitigation actions. Such monitoring includes reviewing Bay Area pesticide sales and use data, pesticide fate and transport data, and public attitudes regarding pesticides and water quality. If undertaken, this monitoring could seek to answer the following questions:

- What pesticides pose the greatest water quality risks?
- How is the use of such pesticides changing?
- Are existing actions effective in reducing pesticide discharges?
- What approach is best for monitoring toxicity and pesticides in urban creek water and sediment?

MONITORING BENCHMARKS

To determine whether measured or predicted pesticide concentrations are cause for concern, monitoring benchmarks are needed. Ideally, water quality criteria would be used; however, water quality criteria do not exist for most pesticides. The U.S. Environmental Protection Agency requires specific toxicity data to develop water quality criteria (USEPA 1985), and available data are rarely sufficient. To register a pesticide, the U.S. Environmental Protection Agency requires toxicity data that only satisfy three of eight water quality criteria data requirements. Typically, registering a pesticide requires data for *Daphnia magna* (a daphnid like *Ceriodaphnia dubia*; a tiny crustacean), *Oncorhynchus mykiss* (rainbow trout or steelhead; a salmonid), and *Lepomis macrochirus* (bluegill) (40 CFR §158.490).

In the absence of water quality criteria, monitoring benchmarks should be set at concentrations at or below the water quality criteria that would likely be calculated if sufficient data were available. The U.S. Environmental Protection Agency addressed this issue in its "Water Quality Guidance for the Great Lakes System" (40 CFR Part 132, Appendix A). The U.S. Environmental Protection Agency based its approach on an analysis of how its water quality criteria relate to available toxicity data (USEPA 1991b). This approach only addresses water column quality, not sediment quality.

To adjust for the uncertainty introduced by missing data, the U.S. Environmental Protection Agency identified factors to be applied to the lowest available "genus mean acute value" (defined as the geometric mean of the available "species mean acute values" within a genus, which in turn are defined as the geometric means of available 96-hour LC_{50} values for each species). For purposes of this discussion, these factors will be referred to as "safety" factors. When fewer data requirements are met, larger "safety" factors are applied. For the Great Lakes system, the U.S. Environmental Protection Agency selected its "safety" factors from among various options (USEPA 1991b) based on its expertise and judgment. Its factors reflect an assumption that daphnid data are available. To calculate a value analogous to an acute criterion, the U.S. Environmental Protection Agency's guidance for the Great Lakes system calls for dividing the lowest available "genus mean acute value" by the "safety" factor (which depends on how many data requirements are met) and then dividing the result by two.

TABLE 11.1
Factors for Determining Monitoring Benchmarks

Number of Data Requirements Satisfied [a]	"Safety" Factor [b]	"Benchmark" Factor
2	7.89	16
3	7.14	14
4	7.14	14
5	6.06	12
6	4.99	10
7	4.30	8

[a] The U.S. Environmental Protection Agency's water quality criteria guidelines require data for at least eight taxonomic families to derive water quality criteria (USEPA 1985).
[b] The "safety" factors are the same as the "final acute value factors" the U.S. Environmental Protection Agency study labeled as "median of 95th percentiles" for the case where both daphnid and salmonid data requirements are met (USEPA 1991b); therefore, these factors only apply when both daphnid and salmonid toxicity data are available.

Using the same approach, but assuming that both daphnid and salmonid data are available (as should be the case when pesticides are registered), Table 11.1 lists appropriate "safety" factors for calculating monitoring benchmarks. Applying the additional factor of two results in factors that can be used to generate monitoring benchmarks analogous to acute criteria. For purposes of this discussion, these factors will be referred to as "benchmark" factors. Monitoring benchmarks for pesticides may be calculated by dividing the lowest available "genus mean acute value" by the "benchmark" factor in Table 11.1 corresponding to the number of "genus mean acute values" available that satisfy water quality criteria data requirements. Because data for registered pesticides typically provide at least three "genus mean acute values," the "benchmark" factors will typically be 14 or less.

Monitoring Benchmark = Lowest Genus Mean Acute Value ÷ Safety Factor ÷ 2
or
Monitoring Benchmark = Lowest Genus Mean Acute Value ÷ (Safety Factor x 2)
or
Monitoring Benchmark = Lowest Genus Mean Acute Value ÷ Benchmark Factor

Monitoring benchmarks can also be calculated using the lowest available LC_{50} for a valid 96-hour toxicity test instead of the lowest available "genus mean acute value." This approach is more conservative because it could result in lower values.

In most cases, these monitoring benchmarks would be the same as or lower than the acute water quality criterion that would be calculated if sufficient data were available. Because they are roughly analogous to acute criteria, the monitoring benchmarks would generally be appropriate for water column monitoring; most Bay Area urban creek pesticide monitoring is conducted by collecting instantaneous grab samples, which correspond roughly to acute (one-hour average) concentrations, not chronic (four-day average) concentrations.

Monitoring benchmarks may be useful tools in determining compliance with narrative objectives. When monitoring data demonstrate that pesticide concentrations exceed monitoring benchmarks, the information can be considered during periodic reviews undertaken as part of adaptive implementation (see below). The Water Board may use the monitoring benchmarks to evaluate water quality and may seek additional toxicity data to derive water quality criteria for pesticides that exceed monitoring benchmarks. The Water Board will inform other regulatory agencies (e.g., the California Department of Pesticide Regulation) about potential threats to water quality and seek action to prevent water quality impairment.

ADAPTIVE IMPLEMENTATION

Adaptive implementation entails taking immediate actions commensurate with available information, reviewing new information as it becomes available, and modifying actions as necessary based on the new information. Taking immediate action allows progress to occur while more and better information is collected and the effectiveness of current actions is evaluated. Table 11.2 lists specific actions the Water Board will use to track its progress, an implementation timeframe, and an associated rationale.

Periodic Review

The proposed Basin Plan Amendment calls for the Water Board to review the strategy approximately every five years. If any modifications are needed, they will be incorporated into the Basin Plan. Water Board staff will monitor the actions of the various parties identified in the implementation plan, including the Water Board, the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, urban runoff management agencies, and others, and assess the effectiveness of actions taken to control pesticide discharges. At a minimum, the following focusing questions will be used to conduct the reviews. Additional focusing questions will be developed in collaboration with stakeholders during each review.

1. Are changes in urban creek conditions moving toward improvements in water quality (e.g., toward target attainment)?
2. If it is unclear whether there is progress, how should monitoring efforts be modified to measure trends?
3. If there has not been adequate progress, how might the implementation actions or allocations be modified?
4. Is there new information that suggests the need to modify the targets, allocations, or implementation actions?
5. If so, how should the strategy be modified?

During the periodic reviews, the Water Board will consider newly available information regarding such topics as market trends, monitoring results, tools for risk evaluation, outreach effectiveness, and regulatory actions.

Critical Data Needs

Various types of information and tools are needed to adequately evaluate the risks associated with pesticide runoff. To the extent possible, the pesticide industry should shoulder the burden of collecting this information and developing appropriate tools. At times, however, the citizens of the Bay Area (as represented by the Water Board, the urban runoff management agencies, and others) will need to lead by example. The following actions are needed to address critical data needs:

- Conduct surveillance monitoring of surface waters and sediment and publicly report the results;
- Develop publicly available and commercially viable analytical methods to detect ecologically relevant concentrations of pesticides that pose water quality risks;

TABLE 11.2
Water Board Implementation Measure Tracking

Action	Schedule	Rationale for Schedule
Summarize pesticide regulatory activities as they relate to water quality, and identify opportunities to advise pesticide regulatory oversight agencies regarding future actions	Annually	Current practice is to review these regulatory activities each year
Summarize research and monitoring data for pesticide regulatory oversight agencies and others, and determine where to focus future monitoring efforts based on critical data needs	Annually	Current practice is to review research and monitoring activities each year
Describe urban pesticide use trends and identify pesticides likely to affect water quality	Annually	Current practice is to review pesticide use trends each year
Notify pesticide regulatory oversight agencies if water quality standard violations exist or are likely to exist in the future due to pesticide discharges	At least annually	Information regarding actual or potential water quality standard violations could arise with annual monitoring and possibly seasonal results
Identify waters impaired by pesticide-related toxicity and waters where there is a potential for impairment	Biannually	The §303(d) listing process currently takes place biannually
Meet or correspond with pesticide regulatory oversight agencies regarding their roles in protecting water quality	At least annually	Meetings and correspondence currently take place several times each year
Place required actions in NPDES storm water permits	No later than five years from effective date of strategy	Permits must be reissued every five years
Report implementation status to Water Board	Annually	An annual status report will allow the Water Board to oversee implementation

- Develop procedures that can be used to identify potential causes of toxicity in water and sediment (e.g., Toxicity Identification Evaluation procedures);
- Complete publicly available studies that characterize the fate and transport of pesticides applied in urban areas;
- Develop and adopt evaluation methods (e.g., quantitative fate and transport models) for urban pesticide applications, including applications to impervious surfaces; and
- Complete publicly available studies to support the development of water quality criteria for pesticides in water and sediment.

KEY POINTS

- Municipal urban runoff permits require dischargers to characterize their discharges, which necessarily involves monitoring toxicity and specific pollutants in receiving waters.
- Urban runoff management agencies will design and implement acceptable monitoring programs.
- The strategy includes a method to determine appropriate monitoring benchmarks for specific pesticides in water.
- The need for comprehensive pesticide-related water quality monitoring may be moderated by efforts to monitor other factors, which serve as surrogates or indicators of water quality conditions.
- The strategy will be reviewed approximately every five years.
- If implementing this strategy proves inadequate, additional measures could be needed.

12. EARLY IMPLEMENTATION

This section reviews implementation actions already underway. Since pesticide-related toxicity was discovered in urban creeks in the early 1990s, many parties have initiated efforts to confront the problem. Reviewing these efforts provides context for the actions listed in Section 10, "Proposed Implementation Actions."

WATER BOARD

The Water Board has incorporated many pesticide-related actions into its ongoing programs through its existing authorities. For example, the Water Board has included pollutant-specific provisions in urban runoff discharge permits. These provisions have increased attention to pesticide-related issues by urban runoff management agencies (discussed below). The Water Boards have also awarded several grants, listed in Table 12.1, that benefit the Bay Area by supporting actions this strategy identifies. California Proposition 13 funds these grants.

In addition, the Water Board hosts the Urban Pesticide Committee. In the early 1990s, when pesticide-related toxicity was first found in urban creeks, San Francisco Bay and Central Valley Water Board staff convened stakeholders to address the problem. They named the stakeholder group the "Urban Pesticide Toxicity Control Strategy— Bay Area / Central Valley Coordinating Committee," often simply called the "Urban Pesticide Committee." Stakeholders included the Water Boards, the California Department of Pesticide Regulation, the U.S. Environmental Protection Agency, urban runoff management agencies, wastewater agencies, industry representatives, environmental organizations, and technical experts. The Urban Pesticide Committee established that its mission would be "to identify and promote the implementation of effective means of preventing or eliminating negative impacts to surface waters and sediments caused by pesticides used in urban areas of the San Francisco Bay/Delta Area and its tributaries."

The Urban Pesticide Committee worked to develop a strategy involving a three-pronged approach, focusing on science, regulation, and outreach. These are essentially the same three cornerstones that serve as the foundation for the implementation strategy proposed in Section 10, "Proposed Implementation Actions." No authoritative body ever formally completed or adopted the Urban Pesticide Committee's strategy, but as discussed below, many participants began implementing portions of it.

The Urban Pesticide Committee is believed to be the only group of its kind in the nation addressing pesticides and water quality in the urban context. Its bimonthly meetings provide an important information gathering and sharing forum, and it serves as the stakeholder forum for this pesticide-related water quality attainment strategy. With adoption of this proposed strategy, the Urban Pesticide Committee is poised to serve a new function as a forum for coordinating and tracking the implementation plan.

TABLE 12.1
Urban Pesticide-Related Grants Benefiting the Bay Area

Project	Scope of Work
Urban Pesticides Pollution Prevention (UP3) Project Contractor: San Francisco Estuary Project Award: $572,000	• Provide support to entities implementing pesticide outreach. • Manage stakeholder network through Urban Pesticide Committee. • Work with urban runoff programs to improve pesticide toxicity control plans. • Integrate science and pesticide use information into mitigation. • Prepare annual urban pesticide market report; track urban pesticide use trends. • Review new urban-use insecticides for water quality implications. • Facilitate local agency involvement in regulatory processes.
Alternatives to a Toxic Tomorrow Contractor: Marin County Stormwater Pollution Prevention Program Award: $500,000	• Work with three pesticide distributors to ensure availability of less toxic products. • Provide fact sheets and display stands for in-store displays. (At least 250 stores will participate in Bay Area and north and central coast regions.) • Train distributor sales staff in north and central coast regions (training already occurs in Bay Area). • Assist local groups in promoting project. • Offer at least 80 point-of-purchase educational sessions for public. • Gather sales data on less toxic products. • Host a website allowing consumers to get answers to questions. (Bio-Integral Resource Center responds to all requests.) • Offer four one-day workshops for elementary school teachers.
Pest Control Operator Integrated Pest Management (IPM) Partnership Contractor: Bio-Integral Resource Center Award: $240,000	• Identify two Bay Area Pest Control Operators willing to implement integrated pest management programs. • Develop integrated pest management protocols that Pest Control Operators should follow. • Develop integrated pest management training and have pilot Pest Control Operator staff attend. • Develop standards for integrated pest management practices and criteria for integrated pest management certification. • Develop program to effectively market integrated pest management services. • Develop an integrated pest management marketing curriculum to supplement technical integrated pest management training. • Provide marketing course to pilot Pest Control Operator staff. • Conduct a nine-month pilot integrated pest management program with selected Pest Control Operators. • Market integrated pest management to Pest Control Operators.
Making IPM Mainstream: Tools and Market-Based Incentives for Improving Urban Water Quality Contractor: Association of Bay Area Governments Award: $785,000	• Develop landscaping IPM practices, training curricula and certification standards. • Train Bay Area and Sacramento structural pest control and landscaping professionals and local agency managers. • Implement integrated pest management certification programs. • Market integrated pest management certification in Bay Area. • Retain a public relations firm to promote certification.

Project	Scope of Work
Development of New Chemical Methods for the Diazinon Replacements Contractor: San Francisco Estuary Institute Award: $189,911	• Develop new or improved analytical methods for pyrethroids (including deltamethrin), carbamates (including carbaryl), imidacloprid, and piperonyl butoxide. • Compare methods using laboratory and environmental samples. • Collect and analyze water and sediment samples in northern reach of San Francisco Estuary.
Development of Testing Procedures for Diazinon and Chlorpyrifos Replacement Pesticides Contractor: San Francisco Estuary Institute Award: $190,002	• Develop Toxicity Identification Evaluation procedures for pyrethroids and imidacloprid in surface water. • Evaluate pyrethroid toxicity differences at different temperatures. • Examine permethrin, bifenthrin, cypermethrin, cyfluthrin, esfenvalerate, and lambda-cyhalothrin toxicity profiles. • Test possible methods of removing pyrethroid toxicity from samples. • Examine ways to reduce pyrethroid adsorption to containers. • Develop standard procedures for monitoring pyrethroids.
Investigations of Sources and Effects of Pyrethroid Pesticides in Watersheds of the San Francisco Estuary Contractor: San Francisco Estuary Institute Award: $188,445	• Conduct field study to determine if San Francisco Estuary sediment is toxic. • Characterize contaminant levels in collected sediment. • If samples are toxic, perform Toxicity Identification Evaluations to identify causes. • Develop cypermethrin, permethrin, and bifenthrin dose-response information for standard sediment toxicity test species. • Develop Toxicity Identification Evaluation procedures for pyrethroids in sediment.

Water Board staff tracks U.S. Environmental Protection Agency pesticide registration processes, and when invited, submits water quality-related comments. Past comments have related to diazinon, chlorpyrifos, malathion, carbaryl, atrazine, lindane, pentachlorophenol, creosote, 2,4-dichlorophenoxyacetic acid, and pyrethrins (SFBRWQCB 2000; SFBRWQCB 2001a,b; SFBRWQCB 2002a,b,c; SFBRWQCB 2003b; SFBRWQCB 2004b,d,e,g; SFBRWQCB 2005a,b,f,i). The comments identify gaps in pesticide regulation that could affect water quality and request that the U.S. Environmental Protection Agency act to eliminate water quality risks when pesticides are registered, so as to avoid future water quality impairment.

U.S. ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency phased out residential end use diazinon products. This action is expected to eventually eliminate diazinon-related toxicity in urban creeks. To ensure that other pesticides do not cause toxicity, the U.S. Environmental Protection Agency's Office of Pesticide Programs and Office of Water are beginning to work together to coordinate their regulatory programs. The most recent example of this coordination involves atrazine, an herbicide. The Office of Water recently proposed ambient aquatic life water quality criteria for atrazine in concert with the Office of Pesticide Program's reregistration process (USEPA 2003a,b). The Office of Pesticide Programs relied on the water quality criteria for its interim registration eligibility decision. As a condition of continuing registration, the Office of Pesticide Programs required atrazine registrants to conduct some water quality monitoring and, if exceedances of the new water quality criteria are discovered, the registrants are to "initiate and conduct a TMDL or comparable watershed management program...." This recent coordination between the Office of Pesticide Programs and the Office of Water is a positive development, but additional efforts are needed to prevent pollution before it occurs.

U.S. Environmental Protection Agency Region IX pesticide and water quality staff works with the Water Boards and pesticide lead agencies on pesticide and water quality issues in the western states. Region IX staff actively participates in the Urban Pesticide Committee and communicates regional water quality concerns about urban pesticides to U.S. Environmental Protection Agency headquarters.

CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION

The California Department of Pesticide Regulation has participated in the Urban Pesticide Committee since the committee's inception. It also participates in the Marina and Recreational Boating Workgroup of the Non-Point Source Interagency Coordination Committee, which addresses the use of copper-based pesticides in antifouling paints. In implementing the Healthy Schools Act, the California Department of Pesticide Regulation promotes integrated pest management at California schools.

The California Department of Pesticide Regulation has supported several studies pertinent to the water quality impacts of urban pesticide use. These studies evaluated organophosphorus pesticide concentrations in sewage, diazinon runoff from paved surfaces, water quality implications of diazinon formulations and sites of use, and residential pesticide use behavior and attitudes. The California Department of Pesticide Regulation has supported promising urban integrated pest management and outreach projects through its pest management and alliance grants. In addition, it has reviewed and offered advice to the Water Boards regarding pesticide-related water quality grant programs. It participates in the Pest Control Operators Integrated Pest Management Partnership, which is funded through a Proposition 13 grant.

Within the California Department of Pesticide Regulation, an Urban Pesticide Initiative Workgroup is developing internal recommendations for management related to urban pesticide monitoring, mitigation, and outreach. These recommendations may help shape the agency's future urban pesticide activities. In conjunction with this workgroup's efforts, the agency has contracted with the University of California Statewide Integrated Pest Management Program to comprehensively identify urban pesticide user groups, explore each group's use practices, review past outreach programs, and develop an appropriate outreach strategy for each group.

URBAN RUNOFF MANAGEMENT AGENCIES

On behalf of Bay Area urban runoff management agencies, the Bay Area Stormwater Management Agencies Association prepared a *Strategy for Reducing Organophosphate Pesticide-Related Toxicity in San Francisco Bay Area Urban Creeks* (BASMAA 2000). The strategy identifies actions that local, regional, state, and federal agencies are or should be taking to address pesticides, particularly diazinon. The strategy calls for measures related to education, regulation, monitoring, coordination, and evaluation. The urban runoff management agencies have since been implementing their portion of the strategy to various degrees. They have taken the lead in terms of educating Bay Area residents and other audiences about pesticide-related toxicity, less toxic pest control, and proper use and disposal of pesticides.

Urban Runoff Permits

The Water Board's most recent urban runoff permits require urban runoff management agencies to implement a number of measures to reduce pesticide discharges that threaten water quality. These measures are consistent with the *Strategy for Reducing Organophosphate Pesticide-Related Toxicity in San Francisco Bay Area Urban Creeks*. Agencies are implementing these provisions, including the following:

- Preparing and implementing pesticide toxicity control plans to address municipal pesticide use and pesticide use by others.
- Tracking municipal pesticide use.
- Adopting and implementing policies, procedures, or ordinances to minimize pesticide use and require integrated pest management in municipal operations.
- Training municipal employees who use pesticides to protect water quality.
- Implementing education and outreach programs targeting residential and commercial pesticide users and pest control operators.
- Encouraging retailers to sell less toxic alternatives and facilitate point-of-sale outreach efforts.
- Minimizing impervious surfaces and incorporating urban runoff detention and retention techniques through design, landscaping, and environmental reviews of proposed development projects.
- Coordinating with household hazardous waste collection agencies to support, enhance, and publicize proper pesticide disposal programs.
- Helping pesticide regulators and manufacturers understand the adverse impacts of pesticides on urban creeks and encouraging them to curtail pesticide use that poses water quality risks.

Program Highlights

Municipal urban runoff management agencies are undertaking a number of programs to implement the *Strategy for Reducing Organophosphate Pesticide-Related Toxicity in San Francisco Bay Area Urban Creeks* and meet urban runoff permit requirements. The Regional Integrated Pest Management Partnership is one of their most visible programs. Local and regional water pollution prevention agencies are collaborating with local nurseries and hardware stores to promote less toxic pest prevention and control through point-of-sale outreach. The program, also known as "Our Water, Our World," involves partnering with retailers to spread the word about water quality problems related to residential pesticide use and educating the public about less toxic pest control. Information is posted at www.ourwaterourworld.org, a web site funded through a Proposition 13 grant.

The Regional Integrated Pest Management Partnership aims to protect local creeks and San Francisco Bay from pesticide discharges. Agencies have developed an extensive list of less toxic pest control methods and products, produced educational materials, designed and produced in-store promotional materials for less toxic products, and trained store employees. Participating stores stock a significant number of less toxic products, use shelf labels to identify these products, send employees to training, and provide program fact sheets containing specific less toxic pest management strategies to customers.

Urban runoff management agencies also implement media campaigns involving print, radio, and web-based outreach, and many provide information at community events. Several urban runoff management agencies also provide pest control operator training workshops that promote practices that protect water quality. The California Department of Pesticide Regulation and the Structural Pest Control Board accredit the workshops, and participating pest control professionals receive continuing education credits good toward fulfilling their licensing requirements. Many urban runoff management agencies have also adopted policies or ordinances to minimize pesticide use within their operations.

The California Stormwater Quality Association and other agencies have actively participated in the U.S. Environmental Protection Agency's reregistration process for diazinon and other pesticides (e.g., chlorpyrifos, malathion, carbaryl, and atrazine) that pose water quality concerns.

UNIVERSITY OF CALIFORNIA STATEWIDE INTEGRATED PEST MANAGEMENT PROGRAM

The University of California Statewide Integrated Pest Management Program has disseminated information about less toxic pest management methods for homes and gardens for many years. Each day, over 15,000 people access its web site, which contains information on how to manage more than 120 common garden and household pests using integrated pest management. The program has also distributed over 300,000 consumer information cards for 14 pest problems through Master Gardeners and the University of California Cooperative Extensions. The program offers educational workshops for public and private pest management professionals.

KEY POINTS

- Since pesticide-related toxicity was discovered in urban creeks in the early 1990s, many parties, including the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and urban runoff management agencies, have initiated efforts to confront the problem.
- The Water Board is implementing many pesticide-related actions through its ongoing programs using its existing authorities.

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Regulatory Analyses

13. ENVIRONMENTAL IMPACTS AND ALTERNATIVES ANALYSES

This section includes the environmental impact and alternatives analyses required under the California Environmental Quality Act.

ENVIRONMENTAL IMPACTS

This report is a Functional Equivalent Document and fulfills California Environmental Quality Act environmental documentation requirements. The California Environmental Quality Act requires agencies to review the potential for their actions to result in adverse environmental impacts. Additionally, when an agency adopts a rule or regulation requiring a performance standard (e.g., the targets and allocations proposed here), it must analyze the environmental impacts of the reasonably foreseeable methods of compliance. For this proposed strategy and TMDL, the reasonably foreseeable method of compliance with the targets and allocations is set forth in the implementation plan (see Section 10, "Proposed Implementation Actions" and Section 11, "Monitoring and Adaptive Implementation"). Since the implementation plan specifies the method of compliance, no other alternative method of compliance is reasonably foreseeable. Costs associated with implementing the proposed targets and allocations are discussed in Section 14, "Economic Considerations."

The California Environmental Quality Act also requires agencies to adopt feasible measures to mitigate potentially significant impacts. Appendix B contains the environmental checklist for the proposed Basin Plan Amendment. An explanation follows the environmental checklist and provides details concerning the environmental impact assessment. The analysis concludes that adopting and complying with the proposed Basin Plan Amendment will not have any significant adverse environmental effects. Therefore, no mitigation is necessary.

ALTERNATIVES

The California Environmental Quality Act and Water Board regulations require the Water Board to consider alternatives to the project to reduce any significant environmental impacts. To illustrate how some of the choices made in developing the proposed Basin Plan Amendment affect its foreseeable outcomes, this analysis considers a range of alternatives to the Basin Plan Amendment. It discusses how each alternative would affect foreseeable outcomes, particularly in terms of potential environmental impacts, and the extent to which the alternative would achieve the goals of the proposed Basin Plan Amendment. The alternative scenarios considered below involve a variety of targets and implementation strategies. They include the following:

1. Proposed Basin Plan Amendment,
2. No Basin Plan Amendment,

3. Exclusive diazinon focus,
4. Different diazinon concentration target, and
5. Exclusive use of Water Board authorities.

As discussed in Appendix B, Environmental Checklist, the proposed Basin Plan Amendment does not pose any significant adverse environmental impacts; therefore, these alternatives would not avoid or lessen any significant adverse impacts compared to the proposed Basin Plan Amendment.

Proposed Basin Plan Amendment

The proposed project is the adoption of the Basin Plan Amendment presented in Appendix A. The Basin Plan Amendment contains a water quality attainment strategy and TMDL based on the analyses provided in Sections 2 through 12 of this report. It includes toxicity and diazinon concentration targets for Bay Area urban creeks and assigns wasteload allocations to urban runoff to achieve the targets. The Basin Plan Amendment includes an implementation plan that calls for eliminating and preventing pesticide-related toxicity in Bay Area urban creeks. The plan encourages pest management alternatives that protect water quality and discourages the use of pesticides that run off and threaten water quality. Strategy implementation focuses on regulatory programs, education and outreach, and research and monitoring. Responsibility for solving the pesticide-related toxicity problem is shared among many entities, including the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, urban runoff management agencies, and others. As discussed above, adopting and implementing the Basin Plan Amendment would not pose any significant adverse environmental impacts (also see Appendix B, "Environmental Checklist").

No Basin Plan Amendment

Under this alternative, the Water Board would not amend the Basin Plan to adopt the proposed strategy and TMDL. Neither the proposed targets nor the proposed allocations would be adopted, and no new implementation actions would be initiated. Assuming no new actions were ever taken to address the impairment of Bay Area urban creeks by diazinon and pesticide-related toxicity, diazinon concentrations would likely continue to decline due to the U.S. Environmental Protection Agency's diazinon phase out. Eventually, Bay Area urban creeks would probably meet the proposed diazinon concentration targets consistently. However, other pesticides (e.g., the pyrethroids) would likely threaten water quality, including sediment quality. To the extent that these pesticides were to cause water column or sediment toxicity, the violation of water quality standards would constitute water quality impairment and would likely result in new impairment listings under Clean Water Act §303(d). The environmental effect of new sources of water quality impairment would be significant. These listings would require the development of TMDLs.

If the Water Board were to decline to adopt a TMDL for the urban creeks listed as impaired pursuant to Clean Water Act §303(d), the Clean Water Act requires the

U.S. Environmental Protection Agency to complete TMDLs for these creeks. How the U.S. Environmental Protection Agency's TMDLs would differ from the proposed Basin Plan Amendment is unknown. The U.S. Environmental Protection Agency would likely rely, at least in part, on analyses completed to date, but it would be free to develop its own TMDLs in any manner it deems appropriate, within legal constraints. For example, the U.S. Environmental Protection Agency's TMDLs could be more like the "Exclusive Diazinon Focus" alternative discussed below. The U.S. Environmental Protection Agency could also select a different diazinon concentration target (i.e., it could select the water quality criteria it developed; however, the current draft criteria are one-hour and four-day averages of 100 ng/l, similar to the proposed target). Although the U.S. Environmental Protection Agency would not impose TMDL implementation plans directly, the Water Board would be expected to incorporate the U.S. Environmental Protection Agency's TMDLs into the Basin Plan through the continuing planning process, which would require implementation.

This alternative would not meet all the Basin Plan Amendment's objectives, as listed in Section 5, "Project Background." It would likely not include available information regarding the potential for pesticides to threaten water quality and not ensure attainment of the narrative water quality objectives that protect Bay Area urban creek beneficial uses, including those related to cold and warm freshwater habitat.

Exclusive Diazinon Focus

Under this alternative, the Water Board would focus exclusively on the diazinon-related toxicity problem and ignore the potential for other pesticides to threaten water quality. Only the proposed diazinon concentration target would be adopted, not the proposed toxicity targets. Like the project, allocations would be assigned to urban runoff, but they would only relate to diazinon. No general pesticide-related actions would be implemented; instead, only actions directly related to diazinon would be implemented. Because the U.S. Environmental Protection Agency phased out almost all urban diazinon uses at the end of 2004, urban runoff management agencies would only be required to promote appropriate handling and disposal of remaining diazinon stocks. Eventually, the diazinon concentration target would be met.

Due to the exclusive diazinon focus, pesticides other than diazinon (e.g., the pyrethroids) would likely threaten water quality. To the extent that these pesticides were to cause water column or sediment toxicity, the violation of water quality standards would constitute water quality impairment and would likely result in new impairment listings under Clean Water Act §303(d). The environmental effect of new sources of water quality impairment would be significant. These listings would require the development of TMDLs.

This alternative would not meet all the Basin Plan Amendment's objectives, as listed in Section 5, "Project Background." It would ignore available information regarding the potential for pesticides other than diazinon to threaten water quality. Therefore, it would probably not attain the narrative water quality objectives that protect beneficial uses.

Moreover, it would waste the resources devoted to developing and adopting the strategy by providing relatively little water quality benefit. Because of the diazinon phase-out, focusing on diazinon exclusively would be a mere paper exercise.

Different Diazinon Concentration Target

Under this alternative, the Water Board would select different diazinon concentration targets. Table 7.2 presents various options, most of which result in higher concentration targets than proposed. Except for the water quality criteria based on U.S. Environmental Protection Agency guidance, the other alternatives have substantial disadvantages, as listed in Table 7.2. They would not be as protective of aquatic life and would not provide the margin of safety inherent in the proposed targets. This concern could be moot, however, because the U.S. Environmental Protection Agency phased out nearly all urban diazinon uses and eventually diazinon concentrations will likely meet all the potential targets listed in Table 7.2. Therefore, the environmental effect of this alternative would be essentially the same as that of the proposed project.

This alternative would not meet all the Basin Plan Amendment's objectives, as listed in Section 5, "Project Background." It may not result in targets that can be shown to attain relevant water quality objectives and, therefore, may not protect beneficial uses. It may also not provide an adequate implicit margin of safety.

Exclusive Use of Water Board Authorities

Under this alternative, the Water Board would rely exclusively on its authorities and not assume that the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, or any other regulatory agency would use its authorities any differently than is current practice. The U.S. Environmental Protection Agency would not reconcile its implementation of the Federal Insecticide, Fungicide, and Rodenticide Act with the Clean Water Act. It would not take steps to predict urban creek pesticide concentrations and develop water quality criteria during its registration processes, and it would not necessarily mitigate predicted pesticide concentrations that exceed water quality criteria. Although the California Department of Pesticide Regulation may respond to water quality impairment when provided with monitoring data it finds compelling, it would not necessarily review new and existing urban pesticide uses to prevent impairment from occurring. It would respond only after actual impairment could be documented.

The Water Board would impose the proposed permit requirements on urban runoff management agencies and other entities responsible for urban runoff discharges. The effect of these requirements would be limited, however, because the California Food and Agricultural Code significantly restricts municipal authority to oversee pesticide applications. Local agencies may not regulate pesticide registration, sale, transportation, or use. Therefore, without regulatory help, the efforts of urban runoff management agencies would probably be insufficient to prevent water quality impairment.

In this scenario, many pesticides could threaten urban creek water quality because their potential ecological risks are not routinely considered within the urban context. To the extent that any pesticides were to cause water column or sediment toxicity, the violation of water quality standards would constitute water quality impairment and would likely result in new impairment listings under Clean Water Act §303(d). The environmental effect of new sources of water quality impairment would be significant. These listings would require the development of TMDLs. Without regulatory action, however, the foreseeable water quality impairment would not be resolved.

Although local agencies may not regulate pesticide use, the Food and Agricultural Code exclusion applies only to local governments, not State of California agencies (e.g., the Water Board). If the U.S. Environmental Protection Agency and the California Department of Pesticide Regulation chose not to act to protect water quality, the Clean Water Act and the Porter-Cologne Water Quality Control Act require the Water Board to use its authorities to protect water quality. Typically, this would include adopting discharge prohibitions and imposing permit requirements. The Basin Plan already contains a discharge prohibition for pesticide discharges (except where the Water Board recognizes a net environmental benefit). However, enforcement of this prohibition is impractical in the context of most urban pesticide use (e.g., over-the-counter use, which is subject to little oversight). Imposing urban runoff permit requirements as proposed would contribute to the solution, but because nearly all the urban runoff permittees are local governments that cannot regulate pesticide practices, the effect of the permit requirements would be limited, as discussed above.

If necessary to protect water quality, the Water Board could consider exercising its authorities in new ways. It could undertake its own water quality evaluations of pesticides with the potential to threaten water quality. The Water Board could seek to fill information gaps through its existing authorities. Pursuant to Water Code §13267, it could possibly attempt to obtain information from pesticide registrants about potential pollutant discharges. Similarly, pursuant to Water Code §13225, it could possibly attempt to obtain information from the California Department of Pesticide Regulation by asking it to investigate and report on technical factors involved in water quality control of pesticide discharges. Based on the information obtained, the Water Board could restrict the use of certain pesticides until proven not to threaten water quality, such as by placing additional regulatory controls on pest control professionals or banning certain applications within the San Francisco Bay Region.

These options would result in the implementation of parallel pesticide regulatory programs by both the Water Board and the California Department of Pesticide Regulation. They would pose substantial enforcement challenges for the Water Board and would be far less efficient than relying on the U.S. Environmental Protection Agency and the California Department of Pesticide Regulation to prevent the use of pesticides that threaten water quality. Without regulatory action, however, water quality impairment would likely be a recurring problem for Bay Area urban creeks. If impairment persisted, habitat-related beneficial uses would be unprotected and could be unattainable. If the Water Board were to fail to ensure attainment of the water quality standards, then the U.S. Environmental Protection Agency would be forced to step in. It is unclear what the U.S. Environmental Protection Agency would do.

This alternative would not meet all the Basin Plan Amendment's objectives, as listed in Section 5, "Project Background." In addition to not necessarily attaining water quality standards applicable to Bay Area urban creeks, it would likely involve actions with unreasonable costs relative to their environmental benefits and would not necessarily result in the burden of strategy implementation being shared appropriately by those responsible for pesticide uses that threaten water quality.

KEY POINTS

- Adopting the proposed Basin Plan Amendment would not result in any significant adverse environment effects.
- The proposed Basin Plan Amendment is the preferred alternative because it best meets the project objectives.

14. ECONOMIC CONSIDERATIONS

This section considers the economic costs of implementing the proposed Basin Plan Amendment. The California Environmental Quality Act requires that, whenever a Water Board adopts a rule that establishes a performance standard, it conduct an environmental analysis of reasonably foreseeable methods of compliance. This analysis must take into account a range of factors, including economic factors. The proposed implementation plan (Section 10, "Proposed Implementation Actions" and Section 11, "Monitoring and Adaptive Implementation") is the foreseeable means of complying with the targets and allocations; therefore, the costs of implementing the strategy and TMDL are estimated below.[*]

COSTS

The discussion below is organized according to the list of agencies and other entities called out in Section 10, "Proposed Implementation Actions." Table 14.1 summarizes the estimated costs described below. The cost estimates are very rough. Costs are difficult to estimate because, although the proposed Basin Plan Amendment explains how the TMDL will be implemented, it does not prescribe the exact actions the parties responsible for implementing the TMDL must take. A menu of options exists from which each entity can choose. Moreover, some entities (e.g., public agencies) will only be able to implement the strategy to the extent that resources are available and allocated for this purpose. Therefore, this economic analysis is primarily illustrative, reflecting the rough magnitude of possible costs.

For analysis purposes, agency staff costs are estimated in terms of person-years (PYs), assuming that each PY costs an agency about $150,000 per year. Actual costs vary, and this estimate may be high. However, when agencies assign staff to a task, they also incur management, administrative, and overhead costs, which can be assumed to be included in the $150,000 per year per PY.

[*] California's Porter-Cologne Water Quality Control Act requires a Water Board to consider economics when it adopts water quality objectives. The analysis typically identifies available methods to comply with the water quality objective and the costs of compliance. If the costs are substantial, the staff report must state why the objective is necessary despite the potential adverse economic consequences. The proposed Basin Plan Amendment does not change any water quality objectives. It implements existing objectives to protect beneficial uses. Therefore, these particular economic analysis requirements do not apply to the Basin Plan Amendment.

TABLE 14.1
Estimated Implementation Costs

Entity	Annual Costs
Water Board	$225,000
U.S. Environmental Protection Agency	$900,000
California Department of Pesticide Regulation	$675,000
County Agricultural Commissioners	$450,000
California Department of Consumer Affairs	$150,000 [a]
University of California Statewide Integrated Pest Management Program	$150,000
Private Entities	
Manufacturers and Formulators	$2,500,000
Distributors and Retailers	~ $0
Pest Control Advisors	~ $0
Pesticide Users	~ $0 [b]
Urban Runoff Management Agencies and Similar Entities	$2,200,000
Total	***$7,250,000***

[a] The Structural Pest Control Board would not incur additional costs following an initial period of action (the proposed actions are unlikely to require significant ongoing efforts after the first year or two of implementation).
[b] Costs that pesticide manufacturers and formulators incur will likely be passed on to pesticide users. Pesticide users and other members of the public will also indirectly pay for costs incurred by the various agencies that implement the strategy.

Water Board

The Water Board is to implement the strategy by taking the actions listed in Table 10.2. In addition, the strategy calls for the Water Board to refine and reconsider the strategy every five years. Adaptively managing the strategy in this way will require Water Board staff resources. For analysis purposes, strategy implementation is assumed to require 1 PY per year, plus contract resources of roughly $75,000 per year, for a total cost of roughly $225,000 per year.

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency is to implement the actions listed in Table 10.3. The U.S. Environmental Protection Agency's commitment to implement these actions is unknown; however, the extent to which the U.S. Environmental Protection Agency assigns resources for these tasks will greatly affect the level of effort other agencies, such as the Water Board and the California Department of Pesticide Regulation, will need to commit to implement their actions. The most cost-effective way to ensure that water quality standards are met is for the U.S. Environmental Protection Agency to implement its actions aggressively. For analysis purposes, U.S. Environmental Protection Agency efforts to implement the strategy are assumed to require 6 PY per year or roughly $900,000 per year. This assumption includes 5 PY for the Office of Pesticide Programs, which registers pesticides, and 1 PY for the Office of Water, which develops water quality criteria. The U.S. Environmental Protection

Agency can use these resources to leverage efforts by pesticide registrants. Commitment of these resources would benefit water quality throughout the nation, in addition to the Bay Area.

California Department of Pesticide Regulation

The California Department of Pesticide Regulation is to implement the actions listed in Table 10.4 and participate in coordination efforts within the California Environmental Protection Agency. For analysis purposes, strategy implementation is assumed to require 3 PY per year, plus contract resources of roughly $225,000 per year, for a total cost of roughly $675,000 per year. Commitment of these resources would benefit water quality throughout California, in addition to the Bay Area.

County Agricultural Commissioners

County Agricultural Commissioners are to implement the actions listed in Table 10.5. For analysis purposes, strategy implementation is assumed to require 3 PY per year, which would be shared by the nine Bay Area County Agricultural Commissioners. The total cost would be roughly $450,000 per year.

California Department of Consumer Affairs

The Structural Pest Control Board within the California Department of Consumer Affairs is to implement the actions listed in Table 10.6. Because of the nature of the proposed actions, they are unlikely to require significant ongoing efforts after the first year or two of implementation. For analysis purposes, strategy implementation is assumed to require 1 PY in total (not per year), which corresponds to a cost of roughly $150,000.

University of California Statewide Integrated Pest Management Program

The University of California Statewide Integrated Pest Management Program is to implement the actions listed in Table 10.7. For analysis purposes, strategy implementation is assumed to require 1 PY per year, which corresponds to a cost of roughly $150,000 per year.

Private Entities

Private entities are to implement the actions listed in Table 10.8. They include manufacturers and formulators, distributors and retailers, pest control advisors, and pesticide users.

Manufacturers and Formulators. Developing and marketing less toxic products can be incorporated into normal business operations. Product development and marketing are routine business expenses. Manufacturers could incur additional costs if regulatory agencies request specific data or analyses to support regulatory decisions. For analysis purposes, five pesticide registrants are assumed to undertake such studies at any particular time, and each is assumed to spend about $500,000 per year, for a total of $2,500,000 per year. Costs that pesticide manufacturers and formulators incur as a result of strategy implementation will likely be passed on to pesticide consumers.

Distributors and Retailers. Offering and promoting less toxic products can be incorporated into normal business operations. Product promotion is a routine business expense. Therefore, for analysis purposes, costs are assumed to be negligible, particularly compared to the other costs considered here.

Pest Control Advisors. Recommending integrated pest management strategies to consumers can be incorporated into normal business operations. Therefore, for analysis purposes, costs are assumed to be negligible, particularly compared to the other costs considered here.

Pesticide Users. Adopting integrated pest management strategies and using less toxic alternatives may cost more or less than existing practices. Integrated pest management services could be more costly than traditional services because they could be more labor-intensive, but they could also be more effective and could involve less pesticide application, which could lower costs in the long term. For analysis purposes, the cost difference is assumed to be negligible. However, pesticide users will likely pay for costs incurred by pesticide manufacturers and formulators, albeit indirectly. Similarly, the general public will indirectly pay for costs incurred by the various agencies that implement the strategy, regardless of whether they apply pesticides or not.

Urban Runoff Management Agencies and Similar Entities

Urban runoff management agencies and similar entities are to implement the actions listed in Table 10.9. Some existing urban runoff permits already explicitly require many of these actions. Therefore, most urban runoff management agencies already implement many strategy actions to varying degrees. The costs of implementing these actions are already accommodated to a large extent within existing budgets. Nevertheless, enhancing pesticide and toxicity monitoring will require additional expenditures.

For context, existing urban runoff management agency programs have been estimated to cost about $29 per household (SWRCB 2005), and there are about 2.5 million households in the Bay Area (ABAG 2003). Therefore, the Bay Area currently spends about $72,000,000 per year specifically to manage urban runoff (not including related activities that would occur with or without urban runoff permits). A separate, smaller study estimated these costs to be roughly $18 per household (LARWQCB 2003) or $45,000,000 per year. For analysis purposes, the costs of implementing the proposed actions are assumed to be roughly 3% of the estimated total of $72,000,000 per year, or about $2,200,000 per year. As a result, strategy implementation would cost each of the roughly 100 Bay Area urban runoff management agencies, on average, about $22,000 per year. Implementation would cost larger dischargers more and smaller dischargers less. As explained above, this cost estimate may significantly overstate foreseeable new costs because many agencies are already implementing required actions.

BENEFITS

When all the strategy actions are considered together, the potential costs could be roughly $7,250,000 per year. However, attaining water quality standards in all impaired Bay Area urban creeks also offers benefits related to the improved potential for the creeks to support freshwater habitats. Less tangible benefits include environmental stewardship, intergenerational equity, and improved ecosystem integrity. These benefits could indirectly result in economic benefits for Bay Area residents by contributing to a relatively high quality of life, making the Bay Area a desirable location to live and conduct business, which would benefit the regional economy.

KEY POINTS

- Implementing the Basin Plan Amendment could place substantial economic burdens on pesticide and water quality agencies and the regulated community to meet existing water quality objectives.
- Implementing the Basin Plan Amendment could also result in environmental and economic benefits.

15. ADMINISTRATIVE PROCEDURES ACT STANDARDS OF REVIEW

This section discusses compliance with California's Administrative Procedures Act standards of review for regulatory provisions.

STANDARDS OF REVIEW

Pursuant to the Administrative Procedures Act, the California Office of Administrative Law reviews proposed regulatory provisions for necessity, authority, reference, consistency, clarity, and non-duplication. The regulatory provisions of the proposed water quality attainment strategy and TMDL are listed in Section 5, "Project Description," and include the proposed targets, the total maximum load for diazinon and pesticide-related toxicity, the allocations, and implementation and monitoring provisions for urban runoff management agencies and similar entities. These regulatory provisions meet the Administrative Procedures Act standards of review, as discussed below.

- ***Necessity***. As discussed in Section 5, "Project Description," the Water Board must develop a TMDL to address urban creeks designated as impaired. The water quality attainment strategy set forth in the proposed Basin Plan Amendment meets this requirement. The strategy, which focuses on pesticide-related toxicity and not exclusively on diazinon, is also needed to prevent future impairment by pesticides other than diazinon, including diazinon-replacement pesticides. This relatively broad approach is warranted considering that, in the Bay Area, most pesticide use occurs in urban areas and the existing Basin Plan provides little specific guidance in terms of how water quality standards relating to pesticide discharges are to be implemented.

- ***Authority.*** The authority for adopting the proposed Basin Plan Amendment comes from Water Code §13240 et seq. and Clean Water Act §303(d)(1) and §303(d)(3).

- ***Reference.*** The reference for the regulatory provisions is the same as the authority: Water Code §13240 et seq. and Clean Water Act §303(d)(1) and §303(d)(3).

- ***Consistency.*** The proposed regulatory provisions are consistent with existing regulatory programs.

- ***Clarity.*** The proposed regulatory provisions are clear because the targets and allocations are numeric and not prone to misinterpretation. The implementation and monitoring requirements for urban runoff management agencies and similar entities are sufficiently detailed to provide clarity.

- ***Non-duplication.*** The proposed regulatory provisions are entirely new. They do not duplicate provisions already in the Basin Plan or other regulations, including those of the State Water Resources Control Board or the California Department of Pesticide Regulation.

KEY POINT

- The proposed Basin Plan Amendment's regulatory provisions meet California's Administrative Procedures Act standards of review.

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Appendix A

Proposed Basin Plan Amendment

PROPOSED BASIN PLAN AMENDMENT

The following changes, shown in double underline/strikeout, apply to the section titled "TOXICITY" in Chapter 3.

Toxicity

All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters. Acute toxicity is defined as a median of less than 90 percent survival, and less than 70 percent survival, 10 percent of the time, or test organisms in a 96-hour static or continuous flow test.

There shall be no chronic toxicity in ambient waters. Chronic toxicity is a detrimental biological effect on growth rate, reproduction, fertilization success, larval development, population abundance, community composition, or any other relevant measure of the health of an organism, population, or community. ~~Chronic toxicity generally results from exposures to pollutants exceeding 96 hours. However, chronic toxicity may also be detected through short-term exposure of critical life stages of organisms.~~

~~As a minimum, compliance will be evaluated using the bioassay requirements contained in Chapter IV~~ Attainment of this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, or toxicity tests (including those described in Chapter IV), or other methods selected by the Water Board. The Water Board will also consider other relevant information and numeric criteria and guidelines for toxic substances developed by other agencies as appropriate.

The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.

The following text, in its entirety, is to be inserted in Chapter 4, immediately after the introduction of the section titled "TOXIC POLLUTANT MANAGEMENT IN THE LARGER SAN FRANCISCO BAY ESTUARY SYSTEM." For clarity, it is not shown with double underline.

Water Quality Attainment Strategy and TMDL for Diazinon and Pesticide-Related Toxicity in Urban Creeks

The following sections establish a water quality attainment strategy and TMDL for diazinon and pesticide-related toxicity in the Region's urban creeks, including actions and monitoring necessary to implement the strategy. The term "pesticides," as used here, refers to substances (or mixtures of substances) intended for defoliating plants, regulating plant growth, or preventing, destroying, repelling, or mitigating pests that may infest or be detrimental to vegetation, humans, animals, or households, or be present in any agricultural or nonagricultural environment. The term "urban creeks," as used here, refers to freshwater streams that flow through urban areas, including incorporated cities and towns and unincorporated areas with similar land use intensities. This strategy applies to all San Francisco Bay Region urban creeks.

The numeric targets, allocations, and implementation plan described below are intended to ensure that urban creeks meet applicable water quality standards established to protect and support beneficial uses. This strategy will also reduce pesticide concentrations in the Bay resulting from urban creek flows. The effectiveness of the implementation actions, the monitoring undertaken to track progress toward meeting the targets, and the most current scientific understanding pertaining to pesticide-related toxicity will be periodically reviewed, and the strategy will be adapted as necessary to reflect changing conditions and information.

Problem Statement

In 1998, a number of the Region's urban creeks were placed on the 303(d) list of impaired waters due to toxicity attributed to diazinon. In the early 1990s, many urban creek water samples collected from selected creeks throughout the Region were toxic to aquatic organisms. Studies found that pesticides, particularly diazinon, caused the toxicity. The 303(d) listings were based on observed toxicity, diazinon detections, and similarities among the Region's urban pesticide use profiles.

When pesticide-related toxicity occurs in urban creek water, creeks do not meet the narrative toxicity objective. When pesticide-related toxicity occurs in sediment, the creeks also do not meet the narrative sediment objective. Likewise, when creek water or sediment is toxic, creeks do not meet the narrative population and community ecology objective. Urban creek waters that fail to meet these objectives are not protective of cold and warm freshwater habitats.

Although U.S. EPA phased out urban diazinon applications at the end of 2004, other pesticides may now pose potential water quality and sediment quality concerns because they are used as diazinon replacements and because pesticide regulatory programs, as currently implemented, allow pesticides to be used in ways that threaten water quality.

Numeric Targets

The numeric targets below interpret the applicable narrative objectives in terms of quantitatively measurable water quality parameters. Meeting these pesticide-related toxicity and diazinon concentration targets will protect cold and warm freshwater habitats. These targets shall be met at all urban creek locations, including those near storm drain outfalls where urban runoff enters receiving waters.

Pesticide-Related Toxicity

The toxicity targets are expressed in terms of acute toxic units (TU_a) and chronic toxic units (TU_c). The targets are as follows: pesticide-related acute and chronic toxicity in urban creek water and sediment, as determined through standard toxicity tests, shall not exceed 1.0 TU_a or 1.0 TU_c, where TU_a = 100/NOAEC and TU_c = 100/NOEC. “NOAEC” refers to the “no observed adverse effect concentration,” which is the highest tested concentration of a sample that causes no observable adverse effect (i.e., mortality) to exposed organisms during an acute toxicity test. For purposes of this strategy, “NOEC” refers to the “no observable effect concentration,” which is the highest tested concentration of a sample that causes no observable effect to exposed organisms during a chronic toxicity test. NOAEC and NOEC are both expressed as the percentage of a sample in a test container (e.g., an undiluted sample has a concentration of 100%). In both cases, an observable effect must be statistically significant. For purposes of this strategy, an undiluted ambient water or sediment sample that does not exhibit an acute or chronic toxic effect that is significantly different from control samples on a statistical basis shall be assumed to meet the relevant target.

The above definitions of TU_a and TU_c apply only to ambient conditions in the context of this diazinon and pesticide-related toxicity strategy. If toxicity exists in urban creeks but pesticides do not cause or contribute to the toxicity, these targets do not apply. Moreover, the numeric toxicity targets do not limit the Water Board’s authority to evaluate attainment of the narrative objectives through other appropriate means.

Diazinon

The diazinon concentration target is as follows: diazinon concentrations in urban creeks shall not exceed 100 ng/l as a one-hour average. The target addresses both acute and chronic diazinon-related toxicity.

Sources

Pesticides, including diazinon, enter urban creeks through urban runoff. Most urban runoff flows through storm drains owned and operated by the Region’s municipalities, industrial dischargers, large institutions (e.g., campuses), construction dischargers, and the California Department of Transportation (Caltrans). Urban runoff contains pesticides as a result of pesticides being manufactured, formulated into products, and sold through distributors and retailers to businesses and individuals who apply them for structural pest control, landscape maintenance, agricultural, and other pest management purposes. Factors that affect pesticide concentrations in urban creeks include the amount used, the chemical and physical properties of the pesticide and its product formulation, the sites of use (e.g., landscaping, turf, or paved surfaces), and irrigation practices and precipitation. In the San Francisco Bay Region, ants are the most common pest problem for which pesticides are used. Argentine ants are an introduced species. Pesticide use by structural pest control professionals and use of products sold over-the-counter can be among the greatest contributors of pesticides in urban runoff.

Total Maximum Daily Load

The assimilative capacity of the Region's urban creeks for diazinon and pesticide-related toxicity is the amount of diazinon and pesticide-related toxicity they can receive without exceeding water quality standards. For urban creeks to assimilate diazinon and other pesticide discharges and meet water quality standards, the targets must be met. Rather than establishing a mass-based TMDL to attain the targets, this TMDL is expressed in concentration units. The TMDL is equal to the targets.

The targets rely on a conservative approach that provides an implicit margin of safety to account for any lack of knowledge concerning the relationship between the allocations and water quality. Weather and seasons affect creek flows and pesticide loads, concentrations, and toxicity. By expressing the targets in terms of toxicity and diazinon concentrations, the inherent pesticide mass loads automatically reflect seasonal and other critical conditions as creek conditions change.

Allocations

The TMDL is allocated to all urban runoff, including urban runoff associated with municipal separate storm sewer systems, Caltrans facilities, and industrial, construction, and institutional sites. The allocations are expressed in terms of toxic units and diazinon concentrations, and are the same as the numeric targets and the TMDL.

Implementation

The cornerstone of this strategy is pollution prevention. Pesticide-related toxicity in the Region's urban creeks is to be eliminated and prevented by using pest management alternatives that protect water quality and by not using pesticides that threaten water quality. This can best be accomplished through the rigorous application of integrated pest management techniques and the use of less toxic pest control methods. The term "integrated pest management," as used here, refers to a process that includes setting action thresholds, monitoring and identifying pests, preventing pests, and controlling pests when necessary. Integrated pest management meets the following conditions:

- Pest control practices focus on long-term pest prevention through a combination of techniques, such as biological control, habitat manipulation, and modification of cultural practices;
- Pesticides are used only after monitoring indicates that they are needed;
- Treatments are made with the goal of removing only the target pest; and
- Pesticides are selected to minimize risks to human health, beneficial and non-target organisms, and the environment, including risks to aquatic habitats.

The term "less toxic pest control," as used here, refers to the use of pest control strategies selected to minimize the potential for pesticide-related toxicity in water and sediment.

Strategy implementation will focus on three areas: (1) regulatory programs, (2) education and outreach, and (3) research and monitoring. Regulatory programs will prevent pollution by using existing regulatory tools to ensure that pesticides are not applied in a manner that results in discharges that threaten urban creek uses. Education and outreach programs will focus on decreasing demand for pesticides that threaten water quality, while increasing awareness of alternatives that pose less risk to water quality. Research will fill existing information gaps, and monitoring will be used to measure implementation progress and success. The actions described below are intended to address these strategic goals.

When pesticide-related toxicity occurs in urban creeks, many entities share responsibility for the discharge, and therefore many entities share responsibility for implementing actions to ensure that pesticide-related toxicity does not threaten water quality. Although the allocations apply to all urban runoff, responsibility for attaining the allocations is not the sole responsibility of urban runoff management agencies, whose authority to regulate pesticide use is constrained. Actions to be implemented by regulatory agencies, urban runoff management agencies, and other entities are listed below. The agencies with the broadest authorities to oversee pesticide use and pesticide discharges include U.S. EPA, the California Department of Pesticide Regulation, and the Water Board. Regulatory and non-regulatory actions are needed to ensure that pesticide use does not result in discharges that cause or contribute to toxicity in urban creeks. Implementing these actions is expected to ensure attainment of the allocations. Many entities are already implementing these actions. Actions that can be required through NPDES permits are already in some permits and shall be incorporated into all applicable NPDES permits when the permits are reissued or by other regulatory actions if appropriate. Voluntary actions should commence immediately, and inter-agency coordination is already underway.

Water Board Actions

The role of the Water Board is to encourage, monitor, and enforce implementation actions, and to lead by example. The Water Board will implement the following actions related to regulatory programs:

- Track U.S. EPA pesticide evaluation and registration activities as they relate to surface water quality and share monitoring and research data with U.S. EPA;
- When necessary, request that U.S. EPA coordinate implementation of the Federal Insecticide, Fungicide, and Rodenticide Act and the Clean Water Act;
- Encourage U.S. EPA to fully address urban water quality concerns within its pesticide registration process;
- Work with the California Department of Pesticide Regulation, County Agricultural Commissioners, and the Structural Pest Control Board to ensure that pesticide applications result in discharges that comply with water quality standards;
- Interpret water quality standards for the California Department of Pesticide Regulation and County Agricultural Commissioners, and assemble available

information (such as monitoring data) to assist the California Department of Pesticide Regulation and County Agricultural Commissioners in taking actions necessary to protect water quality; and
- Use authorities (e.g., through permits or waste discharge requirements) to require implementation of best management practices and control measures to minimize pesticide discharges to urban creeks.

The Water Board will implement the following actions related to outreach and education:

- Encourage integrated pest management and less toxic pest management practices;
- Encourage grant funding for activities likely to reduce pesticide discharges, promote less toxic pest management practices, or otherwise further the goals of this implementation plan; and
- Encourage pilot demonstration projects that show promise for reducing pesticide discharges throughout the Region.

The Water Board will implement the following actions related to research, monitoring, and overall program coordination:

- Promote and support studies to address critical data needs (see Adaptive Implementation, below); and
- Assist municipalities and others implementing this strategy by convening stakeholder forums to coordinate implementation.

U.S. Environmental Protection Agency Actions

U.S. EPA is responsible for implementing the Federal Insecticide, Fungicide, and Rodenticide Act and the Clean Water Act. U.S. EPA is therefore responsible for ensuring that both federal pesticide laws and water quality laws are implemented. U.S. EPA should exercise its authorities to ensure that foreseeable pesticide applications do not cause or contribute to water column or sediment toxicity in the Region's waters. Because some pesticides pose water quality risks, U.S. EPA should implement the following actions:

- Continue internal coordination efforts to ensure that pesticide applications and resulting discharges comply with water quality standards and avoid water quality impairment (i.e., restrict uses or application practices to manage risks);
- Continue and enhance education and outreach programs to encourage integrated pest management and less toxic pest control; and
- Complete studies to address critical data needs (see Adaptive Implementation, below).

California Department of Pesticide Regulation Actions

Like the Water Board, the California Department of Pesticide Regulation is part of the California Environmental Protection Agency. It regulates pesticide product sales and use within California pursuant to the California Food and Agricultural Code. When the

California Department of Pesticide Regulation evaluates whether to register a pesticide product, it must give special attention to the potential for environmental damage, including interference with attainment of water quality standards. The California Department of Pesticide Regulation is mandated to protect water quality from environmentally harmful pesticide materials, which should include pesticides used such that their runoff violates water quality standards. The California Department of Pesticide Regulation should also recognize pesticides used such that their runoff poses a reasonable potential to violate water quality standards to be potentially harmful and take preventive action to address foreseeable risks. The Water Board will assist the California Department of Pesticide Regulation in identifying pesticides that could harm water quality.

The California Department of Pesticide Regulation must endeavor to mitigate adverse effects of pesticides that endanger the environment, such as existing or reasonably foreseeable pesticide-related violations of water quality standards. If a pesticide product has a demonstrated serious uncontrollable adverse effect, mitigation may include canceling its registration. Mitigation is also warranted to avoid existing and reasonably foreseeable serious uncontrolled adverse effects. The Water Board will notify the California Department of Pesticide Regulation whenever it obtains information concerning actual or potential water quality standard violations so the California Department of Pesticide Regulation can implement appropriate protective actions.

To be effective, this strategy relies on the California Department of Pesticide Regulation to use its authorities in concert with the Water Board. Consistent with its authorities, the California Department of Pesticide Regulation should implement the following actions:

- Work with the Water Board to identify pesticides applied in urban areas in such a manner that runoff does or could cause or contribute to water quality standard violations;
- Condition registrations, as appropriate, to require registrants to provide information necessary to determine the potential for their products to cause or contribute to water quality standard violations and to implement actions necessary to prevent violations;
- Continue and enhance efforts to evaluate the potential for registered pesticide products to cause or contribute to water quality standard violations (the California Department of Pesticide Regulation need not wait for the Water Board to evaluate potential water quality effects);
- Implement actions to eliminate pesticide-related water quality standard violations caused by registered pesticides;
- Implement actions to prevent potential pesticide-related water quality standard violations before they occur;
- Notify U.S. EPA of potential deficiencies in product labels for products that threaten water quality;
- Continue and enhance education and outreach programs to encourage integrated pest management and less toxic pest control (work with County Agricultural Commissioners, urban runoff management agencies, and the University of California Statewide Integrated Pest Management Program to coordinate activities);
- Continue and enhance efforts to prevent the introduction of new exotic pests to the Region; and
- Complete studies to address critical data needs (see Adaptive Implementation, below).

Collaboration within the California Environmental Protection Agency

As sister agencies within the California Environmental Protection Agency, the Water Board and the California Department of Pesticide Regulation should coordinate pesticide and water quality regulation in the Region. In 1997, the California Department of Pesticide Regulation and the State Water Resources Control Board entered into a management agency agreement. The California Department of Pesticide Regulation agreed to ensure that compliance with numeric and narrative water quality objectives is achieved. The State and Regional Water Boards retained responsibility for interpreting compliance with narrative water quality objectives. In light of the agreement, the Water Board and the California Department of Pesticide Regulation should work together to eliminate recurrences of water quality standard violations and prevent potential future violations. In consultation with the California Department of Pesticide Regulation, the Water Board will implement the following actions:

- Gather and review available information to identify pesticides most likely to run off into urban creeks and cause or contribute to water quality standard violations;
- Identify evaluation criteria that can be used to discern whether water quality standards are met (e.g., water quality objectives, targets, monitoring benchmarks, or other criteria);
- Evaluate available information to determine whether water quality standards are met and, if so, whether circumstances suggest that future violations are likely; and
- Notify the California Department of Pesticide Regulation and County Agricultural Commissioners if water quality standard violations exist or are likely to exist in the future due to pesticide discharges, thereby enabling these agencies to implement appropriate actions and assisting them in ensuring that their regulatory programs adequately protect water quality.

In consultation with the Water Board, the California Department of Pesticide Regulation should implement the following actions:

- When available information is insufficient to conclude whether water quality standards are met, work with the Water Board to identify information needed to evaluate the potential for pesticide discharges to cause or contribute to water quality standard violations;
- Obtain information necessary to determine whether water quality standards are or are likely to be met from pesticide product registrants, U.S. EPA, and other sources (conservative [i.e., protective] assumptions may be used to fill information gaps);
- Evaluate whether water quality standards are likely to be met (e.g., consider pesticide use, toxicity, application sites and techniques, runoff potential, and environmental persistence; estimate foreseeable water and sediment pesticide concentrations; and consider Water Board evaluation criteria);
- When pesticide discharges are or are likely to cause or contribute to water quality standard violations, identify and evaluate possible corrective actions (using the Water Board's evaluation criteria) and implement those needed to ensure that water quality standards will be met; and

- When available information suggests that pesticide discharges appear likely to cause or contribute to water quality standard violations in the future (assuming standards are currently met), identify and evaluate possible preventive actions and, commensurate with the weight of the evidence, implement those actions needed to ensure that water quality standards will be met.

Sometimes, a pesticide-by-pesticide approach may be counterproductive, particularly if existing pesticide problems are likely to be replaced by new pesticide problems. As appropriate, the California Department of Pesticide Regulation may evaluate several pesticides at once if related to a specific application method, application site of concern, or other shared factor.

During adaptive implementation reviews (see "Adaptive Implementation," below), the Water Board will consider the extent to which inter-agency collaboration is sufficient to address water quality concerns. If necessary, the Water Board will notify the California Department of Pesticide Regulation of deficiencies and could consider the need to use its own regulatory authorities to control pesticide discharges.

County Agricultural Commissioners Actions

County Agricultural Commissioners are the local enforcement agents for the California Department of Pesticide Regulation. They provide local enforcement of applicable pesticide laws and, when necessary to address local circumstances (e.g., localized toxicity in an urban creek), can adopt local regulations (subject to California Department of Pesticide Regulation approval) that govern the conduct of pest control operations and the records and reports of those operations. County Agricultural Commissioners should implement the following actions:

- Continue and enhance enforcement related to illegal sale or use of pesticides, including pesticides sold over-the-counter;
- Continue to enforce the phase out of diazinon products and any new regulations affecting pesticide applications and their water quality risks;
- Continue and enhance efforts to prevent the introduction of new exotic pests to the Region;
- Provide outreach and training to pest control licensees regarding water quality issues as part of pest control business license registration and inspection programs; and
- Work with the California Department of Pesticide Regulation, urban runoff management agencies, and the University of California Statewide Integrated Pest Management Program to coordinate education and outreach programs to minimize pesticide discharges.

Structural Pest Control Board Actions

The Structural Pest Control Board is responsible for licensing structural pest control professionals. The Structural Pest Control Board requires training and examinations to maintain a license to practice structural pest control, and regulates the advertising practices of structural pest control businesses. The Structural Pest Control Board should implement the following actions:

- Through licensing and other authorities, work to ensure that structural pest control practices result in discharges that comply with water quality standards;
- Work to develop a mechanism through which consumers can determine which structural pest control providers offer services most likely to protect water quality; and
- Work to enhance initial and continuing integrated pest management training for structural pest control licensees.

University of California Actions

The University of California Statewide Integrated Pest Management Program promotes pest management education and outreach throughout California. The University of California should implement the following actions:

- Continue and enhance educational efforts targeting urban pesticide users to promote integrated pest management and less toxic pest management practices;
- Continue to encourage and support efforts to identify and improve new less toxic pest management strategies for the urban environment;
- Continue to serve as a resource for information on alternative pest management practices that protect water quality and develop publications others can use to support outreach activities;
- Continue to train University of California Master Gardeners to help disseminate information about integrated pest management and pest management alternatives that protect water quality; and
- Work with the California Department of Pesticide Regulation, County Agricultural Commissioners, and urban runoff management agencies to coordinate education and outreach programs to minimize pesticide discharges.

Urban Runoff Management Agencies and Similar Entities Actions

NPDES permits for urban runoff management agencies and similar entities responsible for controlling urban runoff (e.g., industrial facilities, construction sites, California Department of Transportation facilities, universities, and military installations) shall require implementation of best management practices and control measures. Urban runoff management agencies' and similar entities' respective responsibilities for addressing these allocations and targets will be satisfied by complying with the requirements set forth below and permit-related requirements based on them.

Requirements in each NPDES permit issued or reissued and applicable for the term of the permit shall be based on an updated assessment of control measures intended to reduce pesticides in urban runoff. Control measures implemented by urban runoff management agencies and other entities (except construction and industrial sites) shall reduce pesticides in urban runoff to the maximum extent practicable. Control measures for construction and industrial sites shall reduce discharges based on Best Available Technology Economically Achievable. All permits shall remain consistent with the section of this chapter titled "Surface Water Protection and Management—Point Source Control - Stormwater Discharges." These requirements shall be included in permits no later than five years after the effective date of this strategy. If these requirements prove inadequate to meet the targets and allocations, the Water Board will require additional control measures or call for additional actions by others until the targets and allocations are attained.

The following general requirements shall be implemented through NPDES permits issued or reissued for urban runoff discharges:

1. Reduce reliance on pesticides that threaten water quality by adopting and implementing policies, procedures, or ordinances that minimize the use of pesticides that threaten water quality in the discharger's operations and on the discharger's property;
2. Track progress by periodically reviewing the discharger's pesticide use and pesticide use by its hired contractors;
3. Train the discharger's employees to use integrated pest management techniques and require that they rigorously adhere to integrated pest management practices;
4. Require the discharger's contractors to practice integrated pest management; and
5. Study the effectiveness of the control measures implemented, evaluate attainment of the targets, identify effective actions to be taken in the future, and report conclusions to the Water Board.

The following education and outreach requirements shall also be implemented through NPDES permits issued or reissued for urban runoff discharges:

1. Undertake targeted outreach programs to encourage communities within a discharger's jurisdiction to reduce their reliance on pesticides that threaten water quality, focusing efforts on those most likely to use pesticides that threaten water quality;
2. Work with the California Department of Pesticide Regulation, County Agricultural Commissioners, and the University of California Statewide Integrated Pest Management Program to coordinate education and outreach programs to minimize pesticide discharges.
3. Encourage public and private landscape irrigation management that minimizes pesticide runoff; and
4. Facilitate appropriate pesticide waste disposal, and conduct education and outreach to promote appropriate disposal.

The following monitoring and reporting requirements shall also be implemented through NPDES permits issued or reissued for urban runoff discharges:

1. Monitor diazinon and other pesticides discharged in urban runoff that pose potential water quality threats to urban creeks; monitor toxicity in both water and sediment; and implement alternative monitoring mechanisms, if appropriate, to indirectly evaluate water quality as described below (see Monitoring, below);
2. Disseminate monitoring data to appropriate regulatory agencies; and
3. Contribute to studies to address critical data needs (see Adaptive Implementation, below).

The following requirements related to regulatory programs shall also be implemented through NPDES permits issued or reissued for urban runoff discharges:

1. Track U.S. EPA pesticide evaluation and registration activities as they relate to surface water quality and, when necessary, encourage U.S. EPA to coordinate implementation of the Federal Insecticide, Fungicide, and Rodenticide Act and the

Federal Clean Water Act and to accommodate water quality concerns within its pesticide registration process;
2. Assemble and submit information (such as monitoring data) as needed to assist the California Department of Pesticide Regulation and County Agricultural Commissioners in ensuring that pesticide applications within the Region comply with water quality standards; and
3. Report violations of pesticide regulations (e.g., illegal handing) to County Agricultural Commissioners.

The actions above may be implemented by individual urban runoff management entities, jointly by two or more entities acting in concert, or cooperatively through a regional approach, as appropriate.

NPDES permits issued or reissued for industrial, construction, and California Department of Transportation facilities shall implement the general requirements and education and outreach requirements listed above and monitoring requirements as appropriate.

Private Entities Actions

Most pesticides do not occur naturally in the environment; they are manufactured. Pesticide manufacturers and formulators sell products to distributors and retailers, who sell them to the pesticide users who apply them. These private entities should implement the following actions to prevent pesticide-related toxicity in urban creeks:

- Pesticide manufacturers and formulators should minimize potential pesticide discharges by developing and marketing products designed to avoid discharges that exceed water quality standards. (Many manufacturers successfully market such products.) They should also undertake studies to address critical data needs (see Adaptive Implementation, below);
- Distributors and retailers should offer point-of-sale information on less toxic alternatives. They should also offer and promote less toxic alternatives to customers;
- Pest control advisors should recommend integrated pest management strategies so pesticides that could threaten water quality are used only as a last resort; and
- Pesticide users (e.g., private citizens, professional pesticide applicators, school districts, transit districts, and mosquito abatement and vector control districts) should adopt integrated pest management and less toxic pest control techniques so pesticide applications do not contribute to pesticide runoff and toxicity in urban creeks.

Monitoring

Monitoring is needed to demonstrate target attainment and to track and evaluate the effectiveness of strategy implementation. Diazinon monitoring needs to demonstrate that diazinon concentrations meet the target. When the concentrations consistently drop below the target, such monitoring may no longer be needed. However, because other pesticides will continue to be applied in urban areas, the need to monitor for water and sediment toxicity—and sometimes specific pesticides—will likely remain well after achieving the diazinon concentration target.

A number of programs monitor pesticide concentrations and toxicity in the Region's waters, including the Water Board's Surface Water Ambient Monitoring Program, the California Department of Pesticide Regulation's Surface Water Protection Program, and the Regional Monitoring Program for Trace Substances. Municipal storm water NPDES permits may also require dischargers to characterize their discharges and receiving waters. This can involve monitoring toxicity and specific pollutants, like diazinon, in storm drain systems and urban creeks.

Monitoring Requirements

Monitoring requirements shall be implemented through NPDES permits issued or reissued for urban runoff discharges. Urban runoff management agencies shall undertake monitoring efforts related to pesticides and toxicity. They shall design and implement a monitoring program to answer the following questions:

- Is the diazinon concentration target being met?
- Are the toxicity targets being met?
- Is toxicity observed in urban creeks caused by a pesticide?
- Is urban runoff the source of any observed toxicity in urban creeks?
- How does observed pesticide-related toxicity in urban creeks (or pesticide concentrations contributing to such toxicity) vary in time and magnitude across urban creek watersheds, and what types of pest control practices contribute to such toxicity?
- Are actions already being taken to reduce pesticide discharges sufficient to meet the targets, and if not, what should be done differently?

The monitoring program may be developed by individual urban runoff management agencies, jointly by two or more agencies acting in concert, or cooperatively through a regional approach. Designing the program shall involve characterizing watersheds, selecting representative creeks, identifying sample locations, developing sampling plans, and selecting appropriate analytical tests of water and sediment. Chemical and toxicity tests shall be conducted on urban creek water and sediment. At a minimum, tests shall be used to measure the following:

- Water column toxicity;
- Sediment toxicity;
- Diazinon concentrations in water (until the diazinon concentration target is met consistently); and
- Concentrations of other pesticides that pose potential water quality and sediment quality threats, as feasible.

Sampling frequency, timing, and number of samples shall be adequate to answer the monitoring questions above and any others set forth for the monitoring program.

Additional types of monitoring tools may be used to support and optimize conventional water and sediment monitoring. For example, monitoring in storm drain systems or near application sites may be useful in selecting creek sampling strategies because pesticide concentrations are easier to detect nearer to the pesticide application site. Efforts to monitor parameters that can serve as surrogates or indicators of pesticide-related water quality conditions may moderate the need for more comprehensive water quality monitoring. While some toxicity and pollutant monitoring will always be necessary, extensive monitoring will be less important if other information is collected that can be used to evaluate the potential for toxicity or specific pollutants to occur in water. Alternative monitoring information can also help focus water quality monitoring efforts and mitigation actions. Such monitoring could include reviewing pesticide sales and use data for the Region, pesticide fate and transport data, and public attitudes regarding pesticides and water quality. If undertaken, such monitoring may seek to answer the following questions:

- What pesticides pose the greatest water quality risks?
- How is the use of such pesticides changing?
- Are existing actions effective in reducing pesticide discharges that threaten water quality?
- What approach is best for monitoring toxicity and pesticides in urban creek water and sediment?

Monitoring Benchmarks

To determine whether measured or predicted pesticide concentrations in water are cause for concern, monitoring benchmarks are needed. Ideally, water quality criteria would be used; however, water quality criteria do not exist for most pesticides. In the absence of water quality criteria, a monitoring benchmark may be calculated as follows. Such a monitoring benchmark is not a water quality objective unless adopted as such by the Water Board. Where valid tests have determined four-day LC_{50} values for aquatic organisms (the concentration that kills one half of the test organisms), a monitoring benchmark may be calculated by dividing the lowest LC_{50} value measured by the appropriate benchmark factor from Table 4-x (typically 14 or less for a registered pesticide).

$$\text{Monitoring Benchmark} = \text{Lowest } LC_{50} \div \text{Benchmark Factor}$$

Where multiple LC_{50} measurements are available, the lowest "genus mean acute value" may be used in place of the lowest LC_{50}. The term "genus mean acute value," as used here, refers to the geometric mean of the available "species mean acute values" within a

TABLE 4-x
Benchmark Factors

Number of Data Requirements Satisfied [a]	Benchmark Factor [b]
2	16
3	14
4	14
5	12
6	10
7	8

[a] U.S. EPA water quality criteria guidelines require data for at least eight taxonomic families to derive water quality criteria.
[b] These values apply only when both daphnid and salmonid toxicity data are available. U.S. EPA typically requires such data to register a pesticide.

genus. The term "species mean acute value," as used here, refers to the geometric mean of available four-day LC_{50} values for each species. Other available information regarding the pesticide (such as its potential for sub-lethal effects) may also be considered to determine if lower monitoring benchmarks are appropriate to reflect attainment of the narrative objectives. Table 4-x is not intended for deriving monitoring benchmarks for sediment tests.

When monitoring data demonstrate that pesticide concentrations exceed monitoring benchmarks, the information will be considered during periodic reviews undertaken as part of adaptive implementation (see below). When pesticide concentrations exceed monitoring benchmarks, the Water Board may consider such information in determining compliance with the narrative toxicity, sediment, and population and community ecology objectives. The Water Board may also seek additional toxicity data to derive water quality criteria. The Water Board may inform other regulatory agencies (e.g., the California Department of Pesticide Regulation) about the potential threat to water quality and seek action to prevent water quality impairment.

ADAPTIVE IMPLEMENTATION

Adaptive implementation entails taking immediate actions commensurate with available information, reviewing new information as it becomes available, and modifying actions as necessary based on the new information. Taking immediate action allows progress to occur while more and better information is collected and the effectiveness of current actions is evaluated. Table 4-y lists specific actions the Water Board will use to track its progress and an implementation timeframe.

TABLE 4-y
Water Board Implementation Measure Tracking

Action	Schedule
Summarize pesticide regulatory activities as they relate to water quality, and identify opportunities to advise pesticide regulatory oversight agencies regarding future actions	Annually
Summarize research and monitoring data for pesticide regulatory oversight agencies and others, and determine where to focus future monitoring efforts based on critical data needs	Annually
Describe urban pesticide use trends and identify pesticides likely to affect water quality	Annually
Notify pesticide regulatory oversight agencies if water quality standard violations exist or are likely to exist in the future due to pesticide discharges	At least annually
Identify waters impaired by pesticide-related toxicity and waters where there is a potential for impairment	Biannually
Meet or correspond with pesticide regulatory oversight agencies regarding their roles in protecting water quality	At least annually
Place required actions in NPDES stormwater permits	No later than five years from effective date of strategy
Report implementation status to Water Board	Annually

Periodic Review

The Water Board will review this strategy approximately every five years. The reviews will be coordinated through the Water Board's continuing planning program and will provide opportunities for stakeholder participation. If any modifications are needed, they will be incorporated into the Basin Plan. At a minimum, the following focusing questions will be used to conduct the reviews. Additional focusing questions will be developed in collaboration with stakeholders during each review.

1. Are changes in urban creek conditions moving toward improvements in water quality (e.g., toward target attainment)?
2. If it is unclear whether there is progress, how should monitoring efforts be modified to measure trends?
3. If there has not been adequate progress, how might the implementation actions or allocations be modified to improve progress?
4. Is there new information that suggests the need to modify the targets, allocations, or implementation actions?
5. If so, how should the strategy be modified?

During the periodic reviews, the Water Board will consider newly available information regarding such topics as market trends, monitoring results, tools for risk evaluation, outreach effectiveness, and regulatory actions.

Additional Sources

As the strategy is implemented, additional sources of pesticide-related toxicity may emerge, either as the result of a new discharge or a new pesticide being applied. In such situations, the allocations for additional sources shall be the same as those for the existing sources unless the Water Board finds these allocations to be inappropriate or chooses to refine the strategy in some other manner.

Critical Data Needs

Various types of information and tools are needed to adequately evaluate the risks associated with pesticide runoff. To the extent possible, the pesticide industry should shoulder the burden of collecting this information and developing appropriate tools. At times, however, the citizens of the Region (as represented by the Water Boards, the urban runoff management agencies, and others) should lead by example. Therefore, the pesticide industry should undertake and others should support and promote the following actions:

- Conduct surveillance monitoring of surface waters and sediment and publicly report the results;
- Develop publicly available and commercially viable analytical methods to detect ecologically relevant concentrations of pesticides that pose water quality risks;
- Develop procedures that can be used to identify potential causes of toxicity in water and sediment (e.g., Toxicity Identification Evaluation procedures);
- Complete publicly available studies that characterize the fate and transport of pesticides applied in urban areas;
- Develop and adopt evaluation methods (e.g., quantitative fate and transport models) for urban pesticide applications, including applications to impervious surfaces; and
- Complete publicly available studies to support the development of water quality criteria for pesticides in water and sediment.

The following changes, shown in double underline/strikeout, apply to the section titled "CONTINUING PLANNING" in Chapter 4.

Regional Board Resource Allocation

The items indicated below have been identified in this review as specific areas for which Water Board planning resources should be allocated. The items are divided into categories and each item is followed by an estimate of the frequency at which the item will be reviewed or the staff time and/or contract dollars needed to complete the item. Resolution of these items may result in future Basin Plan amendments.

TOTAL MAXIMUM DAILY LOAD	
Review the Water Quality Attainment Strategy and TMDL for Diazinon and Pesticide-Related Toxicity in Urban Creeks, and evaluate new and relevant information from monitoring, special studies, and scientific literature. Determine if modifications to the targets, allocations, or implementation plan are necessary.	Every 5 years

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Appendix B

Environmental Checklist

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ENVIRONMENTAL CHECKLIST

1. **Project Title:**	Diazinon and Pesticide-Related Toxicity in Bay Area Urban Creeks Water Quality Attainment Strategy and Total Maximum Daily Load (TMDL) Basin Plan Amendment
2. **Lead Agency Name and Address:**	California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, California 94612
3. **Contact Person and Phone Number:**	Bill Johnson (510) 622-2354
4. **Project Location:**	San Francisco Bay Region
5. **Project Sponsor's Name and Address:**	California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, California 94612
6. **General Plan Designation:**	Not Applicable
7. **Zoning:**	Not Applicable

8. **Description of Project:**

   The project is a proposed Basin Plan Amendment to adopt a water quality attainment strategy and TMDL for diazinon and pesticide-related toxicity in Bay Area urban creeks. The project would involve numerous actions to eliminate and prevent pesticide-related toxicity in Bay Area urban creek water and sediment. Additional details are provided in the explanation attached.

9. **Surrounding Land Uses and Setting:**

   The proposed Basin Plan Amendment would affect all Bay Area urban creeks. Implementation would involve specific actions throughout the Bay Area. Bay Area land uses include a mix of residential, commercial, industrial, municipal, agricultural, and open space.

10. **Other public agencies whose approval is required** (e.g., permits, financing approval, or participation agreement.)

    The California State Water Resources Control Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency must approve the proposed Basin Plan Amendment.

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES -- In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. **Would the project:**				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. **Would the project:**				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
III. AIR QUALITY -- (cont.):				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☐	☒
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☐	☒
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☐	☒
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☐	☒
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
IV. BIOLOGICAL RESOURCES -- (cont.):				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒
V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☒
b) Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to §15064.5?	☐	☐	☐	☒
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☒
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VI. GEOLOGY AND SOILS -- (cont.):				
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☒
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VII. HAZARDS AND HAZARDOUS MATERIALS -- (cont.):				
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion of siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VIII. HYDROLOGY AND WATER QUALITY -- (cont.):				
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation of seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING -- Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XI. NOISE -- Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	☒
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XIII. PUBLIC SERVICES --				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:				
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒
XIV. RECREATION --				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION / TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☐	☐	☒
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XV. TRANSPORTATION / TRAFFIC – (cont.):				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS -- Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☒
b) Does the project have impacts that are individually limited, but cumulative considerable? ("Cumulative considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☐	☒
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

EXPLANATION

PROJECT DESCRIPTION

The proposed project is a Basin Plan Amendment to adopt a water quality attainment strategy and TMDL for diazinon and pesticide-related toxicity in Bay Area urban creeks (see Appendix A). The goal of the Basin Plan Amendment is to improve environmental conditions. The Basin Plan Amendment would include toxicity and diazinon concentration targets for urban creeks, and assign wasteload allocations to urban runoff (the source of pesticide discharges) to achieve the targets. The Basin Plan Amendment implementation plan would involve numerous actions to achieve the targets and allocations. The Basin Plan Amendment would affect all Bay Area urban creeks, and implementation actions would occur throughout the Bay Area.

The proposed targets and allocations are measures of performance. The implementation plan outlines the Water Board's approach to meeting these measures of performance. The plan describes actions the Water Board would take and how it would compel, as necessary, other entities to do their parts to eliminate and prevent pesticide-related toxicity in Bay Area urban creeks. The Water Board would not directly undertake any actions that could physically change the environment, but adopting the proposed Basin Plan Amendment could indirectly result in other entities (e.g., cities, counties, and special districts) undertaking projects to satisfy requirements derived from the Basin Plan Amendment. These projects could physically change the environment. The environmental impacts of such physical changes are evaluated below to the extent that they are reasonably foreseeable. Changes that are speculative in nature do not require environmental review.

Direct and Indirect Physical Changes

If the proposed Basin Plan Amendment were adopted, the resulting implementation actions would focus on three areas: (1) regulatory programs, (2) education and outreach, and (3) research and monitoring. Regulatory programs will prevent pollution by using existing regulatory tools to ensure that pesticides are not applied in a manner that results in discharges that threaten urban creek uses. Education and outreach programs will decrease demand for pesticides that threaten water quality, while increasing awareness of less risky alternatives. Research will fill existing information gaps, and monitoring will be used to measure implementation progress and success.

Project-related research and monitoring would not be expected to result in any direct or indirect physical changes. If successful, education and outreach would decrease the use of pesticides that threaten water quality and increase reliance on less risky alternative pest management strategies. The result would typically be lower pesticide concentrations in urban creeks; however, concentrations of some less toxic alternatives could increase. Regulatory programs, if implemented to prevent potential pollution, could result in some pesticides being restricted or phased out. Such pesticides would be present at lower environmental concentrations, and concentrations of replacement pesticides could increase.

Changes Likely With or Without the Basin Plan Amendment

The implementation plan relies on some actions that will occur with or without the proposed Basin Plan Amendment. Because these actions do not result from the Basin Plan Amendment, environmental review is not included in this analysis. The most important action to occur with or without the project is the U.S. Environmental Protection Agency's urban diazinon phase-out, which went into effect at the end of 2004. As a result, urban diazinon use is declining sharply. Use of alternative replacement pesticides is rising. Other actions to occur with or without the Basin Plan Amendment include implementation of existing urban runoff permit provisions regarding diazinon and pesticide-related toxicity and new development. These activities are already underway. However, the Basin Plan Amendment could stimulate more rigorous implementation of these existing requirements.

Changes Too Speculative to Evaluate

Some conceivable effects of the Basin Plan Amendment require speculation and cannot be evaluated in this environmental review. For example, reducing or eliminating some pesticide applications could conceivably increase some pest problems. This would be unlikely because alternative pest control methods are readily available for the most common Bay Area pest problems (e.g., ants, snails, and weeds) and the Basin Plan Amendment would not directly restrict or phase out any pesticide use, particularly when such use offers a net environmental benefit. Therefore, such effects are not considered below.

ENVIRONMENTAL ANALYSIS

As discussed above, physical changes resulting from the Basin Plan Amendment are foreseeable. However, the proposed Basin Plan Amendment does not define all the specific actions urban runoff management agencies could take to comply with requirements derived from the Basin Plan Amendment. The California Environmental Quality Act requires lead agencies to review the potential adverse environmental impacts of projects they approve or undertake. The California Environmental Quality Act further requires lead agencies to adopt feasible measures to mitigate potentially significant impacts. Therefore, the analysis below assumes that lead agencies would adopt mitigation measures necessary to address potentially significant impacts as long as appropriate measures are readily available. Most actions listed in the Basin Plan Amendment would not require a California Environmental Quality Act analysis.

An explanation for each box checked on the environmental checklist is provided below:

I. Aesthetics

a-d) The Basin Plan Amendment would not substantially affect any scenic resource or vista, or degrade the existing visual character or quality of any site or its surroundings. It would not create any new source of light or glare.

II. Agriculture Resources

a-c) The Basin Plan Amendment would not involve the conversion of farmland to non-agricultural use. It would not affect agricultural zoning or any Williamson Act contract.

III. Air Quality

a-e) Because the Basin Plan Amendment would not cause any change in population or employment, it would not generate ongoing traffic-related emissions. It would also not involve any temporary or permanent emissions sources. For these reasons, no permanent change in air emissions would occur, and the Basin Plan Amendment would not conflict with applicable air quality plans, violate any air quality standard, contribute to any air quality violation, contribute to cumulative emissions, or expose sensitive receptors to ongoing pollutant emissions posing health risks or creating objectionable odors.

IV. Biological Resources

a-d) The Basin Plan Amendment is designed to benefit biological resources by protecting aquatic life from pesticide discharges. Therefore, the Basin Plan Amendment would not adversely affect habitats, special-status species, sensitive communities, wildlife, rare or endangered species, wetlands, fish or wildlife movement, migratory corridors, or wildlife nurseries.

e-f) The Basin Plan Amendment would not conflict with local policies or ordinances, including any applicable habitat conservation plans, natural community conservation plans, or other plans intended to protect biological resources. Therefore, the Basin Plan Amendment would not conflict with local policies, ordinances, or adopted plans.

V. Cultural Resources

a-d) The Basin Plan Amendment would not involve any earthmoving, demolition, or construction; therefore, it would not adversely affect any historical, archaeological, or paleontological resource, including human remains.

VI. Geology and Soils

a-d) The Basin Plan Amendment would not involve the construction of habitable structures; therefore, it would not involve any human safety risks related to fault rupture, seismic ground-shaking, ground failure, or landslides. Because the Basin Plan Amendment would not involve any earthmoving, demolition, or construction, it would not result in soil erosion. It would also not create safety or property risks due to unstable or expansive soil.

e) The Basin Plan Amendment would not require wastewater disposal systems; therefore, it would not require soils capable of supporting the use of septic tanks or alternative wastewater disposal systems.

VII. Hazards and Hazardous Materials

a-b) Pollution prevention and outreach could increase pesticide waste generation, which could slightly increase routine hazardous waste disposal volumes throughout the Bay Area. Such efforts would divert pesticide wastes from storm drains, sewers, and solid waste landfills. Outreach efforts could also decrease demand for pesticide products and ultimately reduce the amount of pesticide waste. To the extent that pesticide wastes are diverted from inappropriate waste streams, the Basin Plan Amendment would benefit the environment.

The California Department of Toxic Substances Control oversees hazardous waste handing and disposal. The U.S. Department of Transportation specifies requirements for hazardous materials transportation. Proper handling in accordance with relevant laws and regulations would minimize hazards to the public or the environment, and the potential for accidents or upsets. Therefore, hazardous waste transport and disposal would not create a significant public or environmental hazard.

c-f) Pesticides could be handled within 0.25 mile of a school, on a contaminated site included on the Cortese List, or near an airport or airstrip. However, the Basin Plan Amendment would probably reduce such use, thereby reducing any public or environmental hazards.

g) Hazardous waste management activities resulting from the Basin Plan Amendment would not interfere with any emergency response plans or emergency evacuation plans.

h) The Basin Plan Amendment would not affect the potential for wildland fires.

VIII. Hydrology and Water Quality

a) The project would amend the Basin Plan, which articulates applicable water quality standards; therefore, it would not violate standards or waste discharge requirements. The Basin Plan Amendment is, in fact, intended to ensure attainment of water quality standards.

b) The Basin Plan Amendment would not decrease groundwater supplies or interfere with groundwater recharge.

c-f) The Basin Plan Amendment would not affect existing drainage patterns or increase the amount of impervious surfaces in any watershed. Therefore, it would not increase the rate or amount of runoff, result in erosion, or exceed the capacity of storm water drainage systems. Because the Basin Plan Amendment is intended to reduce pesticide runoff, it would not be a source of new polluted runoff or degrade water quality.

g-j) The Basin Plan Amendment would not include housing or structures that would pose or be subject to flood hazards, or construction subject to risks due to inundation by seiche, tsunami, or mudflow.

IX. Land Use and Planning

a-c) The Basin Plan Amendment would not involve construction; therefore, it would not divide any established community. It would also not conflict with any land use plan, policy, or regulation, and would not conflict with any habitat conservation plan or natural community conservation plan.

X. Mineral Resources

a-b) The Basin Plan Amendment would not involve excavation or construction; therefore, it would not result in the loss of availability of any known mineral resources.

XI. Noise

a-d) The Basin Plan Amendment would not generate noise or groundborne vibration; therefore, it could not be inconsistent with local agency standards.

e-f) The Basin Plan Amendment would not generate aircraft noise. Therefore, it would not expose people living within an area subject to an airport land use plan or in the vicinity of a private airstrip to noise.

XII. Population and Housing

a-c) The Basin Plan Amendment would not affect the population of the Bay Area or California. It would not induce growth through such means as constructing new housing or businesses, or by extending roads or infrastructure. The Basin Plan Amendment would also not displace any existing housing or any people that would need replacement housing.

XIII. Public Services

a) The Basin Plan Amendment would not affect populations or involve construction. The Basin Plan Amendment would not affect service ratios, response times, or other performance objectives for any public services, including fire protection, police protection, schools, or parks.

XIV. Recreation

a-b) Because the Basin Plan Amendment would not affect populations, it would not affect the use of existing parks or recreational facilities. No recreational facilities would need to be constructed or expanded.

XV. Transportation / Traffic

a-b) Because the Basin Plan Amendment would not increase populations or provide employment, it would not generate motor vehicle trips. Therefore, the Basin Plan Amendment would not increase traffic in relation to existing conditions. Levels of service would be unchanged.

c) The Basin Plan Amendment would not affect air traffic.

d) Because the Basin Plan Amendment would not affect any roads or the uses of any roads, it would not result in hazardous design features or incompatible uses.

e) The Basin Plan Amendment would not affect emergency access.

f) Because the Basin Plan Amendment would not increase populations or provide employment, it would not affect parking demand or supply.

g) Because the Basin Plan Amendment would not generate motor vehicle trips, it would not conflict with adopted policies, plans, or programs supporting alternative transportation.

XVI. Utilities and Service Systems

a) The project would amend the Basin Plan, which is the basis for wastewater treatment requirements in the Bay Area; therefore, the Basin Plan Amendment would be consistent with such requirements.

b) Because the Basin Plan Amendment would not affect water demands or supplies, it would not require the construction of new or expanded water or wastewater treatment facilities.

c) Urban runoff management agencies are unlikely to construct any new or expanded storm water drainage facilities to comply with requirements derived from the proposed Basin Plan Amendment.

d-e) Because the Basin Plan Amendment would not increase populations or provide employment, it would not require an ongoing water supply. It would also not require ongoing wastewater treatment services.

f-g) The Basin Plan Amendment would not generate municipal solid waste. Pollution prevention and outreach activities could divert pesticide waste from landfills. However, the Basin Plan Amendment would not substantially affect municipal solid waste generation or landfill capacities.

XVII. Mandatory Findings of Significance

a) The Basin Plan Amendment would not degrade the quality of the environment. The proposed Basin Plan Amendment is intended to benefit aquatic life by decreasing pesticide discharges that threaten water quality. The Basin Plan Amendment is intended to eliminate and prevent pesticide-related toxicity in Bay Area urban creeks.

b) As discussed above, the Basin Plan Amendment would not pose any adverse environmental impacts. Therefore, the incremental effects of the Basin Plan Amendment would be negligible when viewed in the context of overall environmental changes foreseeable in the Bay Area. For this reason, the Basin Plan Amendment would not contribute to cumulative effects.

c) The Basin Plan Amendment would not cause any substantial adverse effects to human beings, either directly or indirectly. The Basin Plan Amendment could benefit human beings as less toxic pest control alternatives are adopted. Alternative pest control strategies could be more or less effective against common Bay Area pests. Because the most common urban pests (e.g., ants, snails, and weeds) pose no health concern, changing the effectiveness of treatment options would have no health consequences. Moreover, less toxic pest control alternatives are readily available, and the Basin Plan Amendment would not restrict pesticide use in cases where a pesticide is needed to confront a substantial human health risk. Therefore, adopting the Basin Plan Amendment would require no mandatory finding of significance.