Development of a Regulatory Approach for OP Pesticide Toxicity to Aquatic Life in Receiving Waters for Urban Stormwater Runoff

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Abstract

Urban stormwater runoff has been found to be toxic to *Ceriodaphnia* due to organophosphate pesticides such as diazinon and chlorpyrifos. Studies of Orange County, CA stormwater runoff as it enters Upper Newport Bay conducted in 1997-98, have shown that up to 10 acute *Ceriodaphnia* toxic units are found in runoff waters. About half of this toxicity is due to diazinon and chlorpyrifos used in residential areas for structural, lawn and garden pest control. Similar organophosphate toxicity for *Ceriodaphnia* has been found for stormwater runoff in the San Francisco Bay, Sacramento, Stockton, Davis, Los Angeles and San Diego areas.

The water quality significance of *Ceriodaphnia* toxicity to the beneficial uses of receiving waters for urban area stormwater runoff needs to be determined. A discussion is presented of the issues that need to be evaluated to determine whether the urban stormwater runoff associated toxicity is significantly adverse to the beneficial uses of the receiving waters for the runoff. The suggested approach is the development of an expert panel to provide guidance to regulatory agencies and others on the conditions that constitute sufficient *Ceriodaphnia* toxicity to warrant curtailment of the urban use of OP pesticides.

- Slides Used in Presentation -

OP Pesticide Toxicity in Upper Newport Bay, Orange County, CA

Stormwater Runoff Toxic to Ceriodaphnia and Mysids
- 10 Toxic Units
- Due to Diazinon, Chlorpyrifos and Unknown Chemicals

OP Pesticide Used for Structural - Termites and Ants, and Lawn and Garden Pests
- Orange County - 50,000 lbs/year Used
  - One-Half by Home Owners' Application

Not Toxic to Fish Larvae or Algae,
- Only Toxic to Certain Zooplankton - Ceriodaphnia, Mysids and others?

Toxicity Present in All Urban Stormwater Runoff and Some Rural Stormwater Runoff

Regulatory Issues

Clean Water Act -- "No Toxics in Toxic Amounts"
- Not Enforced for Urban Stormwater Runoff

Pesticide Registration Regulations
- No Significant Adverse Impacts Due to Pesticide Use

Proposed State Water Board Implementation of California Toxics Rule
- No Toxicity that Impairs Beneficial Uses

No Water Quality Criteria/Standards for Diazinon
- Under Development

Chlorpyrifos Criterion--Not Enforced by US EPA or State
- Not "Priority Pollutant"
- "Up to State to Use Criterion as Standard"

SARWQCB Must Develop TMDL for Toxicity by 2002 Based On Consent Decree
- Will Force Development of Regulatory Approach

Suggested Regulatory Approach

Develop Waterbody Stakeholder Group to Guide Formulation of Regulatory Decisions

Appoint an Executive Committee
- Appoint Technical Leader (TL) to Coordinate, Shepherd, Stimulate and Serve as a Technical Resource to Stakeholder
  - Executive Committee

Develop Funding and Appoint a Consultant to Conduct the Needed Studies Under the Supervision of the TL

TL Review Existing Toxicity Data
- Develop a Report on Data/Information Gaps
- Develop Monitoring/Evaluation Program to Fill Data Gaps

Must Include an Assessment of Total Toxicity Relative to OP Pesticide Caused Toxicity
- Will the Control of OP Pesticide Toxicity Make the Waterbody Non-Toxic?

Determine the Magnitude - Duration and Areal Extent of Toxicity in Stormwater Runoff and Receiving Waters

Develop Stakeholder Consensus on the Magnitude/Extent of the Toxicity that Represents Sufficient Toxicity to be Adverse to the Beneficial Uses of the Waterbody of Concern

Use Expert Panel to Advise Stakeholder Executive Committee on the Development of an Ecological Risk Assessment Approach to Determine the Level and Extent of Toxicity that Represents a Beneficial Use Impairment

Examine the Existing Database to Define the Adequacy of Information for Conducting Ecological Risk Assessment for the OP Pesticide Toxicity Impacts on Aquatic Life

Likely Will Need Detailed Aquatic Organism Assemblage Information Relative to Toxic Conditions to Determine If Receiving Water Populations Likely Impacted Are Actually Impacted by the Presence of OP Pesticides

Also Determine the Relationship Between the Organisms Directly Impacted by OP Pesticide Toxicity and the Numbers, Types and Characteristics of Higher Trophic Level Organisms, Such as Game Fish, That Are of Concern to the Public

Develop Information on the Potential for Reduced Runoff/Use of OP Pesticides that Leads to Presence in Stormwater Runoff at Toxic Levels

Initiation OP Pesticide Control Program if Needed to Control Adverse Impacts on Receiving Water Beneficial Uses

Notify Pesticide Manufacturer(s) That Control of Significant Toxicity in Receiving Waters Due to Stormwater Runoff-Associated OP Pesticides Must be Achieved Within Two Years or Face a Ban on the Use of the Pesticides that Leads to Significant Toxicity in Stormwater Runoff

The Funding of the Necessary Studies and the Regulatory Review Should be Provided by the Pesticide Manufacture(s), Formulators and Users (Public and Private Interests)

If Inadequate Funding Available to Conduct Review, Ban the Use of the Pesticide(s)

The Review Process Should be Planned to be Conducted Over a Three-Year Time Period

OP Pesticide Aquatic Life Toxicity Regulatory Issues

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Presented below is an overview summary of the organophosphate (OP) pesticide aquatic life toxicity problem as it has been defined thus far in California.

The Problem

Organophosphate pesticides are causing aquatic life toxicity in waters throughout the state and, based on OP pesticide use patterns, the nation. The two OP pesticides of greatest concern are diazinon and chlorpyrifos. The agricultural, residential and commercial use of these pesticides for structural (termites and ants) and agricultural and lawn and garden pest control leads to the presence of these pesticides in sufficient concentrations in stormwater runoff and fugitive and excess (tail) irrigation water to be toxic to some forms of aquatic life such as the zooplankters, *Ceriodaphnia* (freshwater) and *Mysidopsis* (marine waters). The concentrations of OP pesticides in urban area and agricultural stormwater runoff are generally below the levels that are toxic to fish and many other forms of aquatic life including other forms of zooplankton. Urban stormwater runoff in the San Francisco Bay area, Sacramento, Stockton, Davis, El Macero, communities in Orange County, CA, Los Angeles and San Diego have been found to be toxic to some forms of aquatic life due to OP pesticides. While the cause of the San Diego and Los Angeles toxicity needs to be confirmed through TIEs, based on the pattern of toxicity found, it is highly likely due to OP pesticides.

Dr. Chris Foe and Dr. Val Connor of the Central Valley Regional Water Quality Control Board (CVRWQCB) have shown that the use of diazinon as a dormant spray in the northern San Joaquin and Sacramento valleys causes stormwater runoff from several hundred miles of these valleys to be toxic to *Ceriodaphnia* associated with its aerial transport and stormwater runoff from its use in orchards. Based on the studies of C. Foe of the CVRWQCB and K. Kuivila of the USGS, (Kuivila and Foe, 1995) it has been found that this use of diazinon causes a toxic pulse lasting a week or more that passes through the Sacramento River and San Joaquin River Delta each winter.

As part of the Sacramento River Watershed Project, Conner, et al., (1998), and Larson, et al., (1998) have found that frequently the main stem of the Sacramento River and several of its major and minor tributaries are toxic to *Ceriodaphnia* associated with stormwater runoff events and for certain waterbodies, between runoff events. Holmes et al., (1998) found that associated with stormwater runoff events in 1994, the Sacramento River contained concentrations of diazinon considerably above the California Department of Fish & Game's recommended water quality criterion. The diazinon was apparently derived from stormwater runoff from orchard areas where it had been used as a dormant spray.

Dr. Vic deVlaming of the State Water Resources Control Board (deVlaming, et al., 1998) has found seasonal toxicity to *Ceriodaphnia* in the Alamo River due to agricultural use of diazinon and chlorpyrifos. The Alamo River is a tributary of the Salton Sea. The Alamo River's flow under low flow conditions is primarily derived from irrigation return (tail) water. deVlaming has also found *Ceriodaphnia* toxicity in the Revolon Slough in Ventura County which is due to chlorpyrifos and diazinon. This slough discharges to the ecological sensitive Mugu Lagoon. The diazinon and chlorpyrifos are apparently derived from the use of these pesticides by agriculture.

Studies of urban stormwater runoff in the San Francisco Bay area by Dr. Tom Mumley, S.R. Hansen, Dr. Scott Ogle and R. Katznelson and several Bay area stormwater quality management agencies (Katznelson and Mumley, 1997) and by Dr. Val Connor, Dr. J. Miller and others in the Sacramento area have found that the toxicity of the urban stormwater runoff that was originally thought to be due to heavy metals was due to diazinon and in some instances chlorpyrifos. Similar aquatic life toxicity results have been found in studies conducted by Dr. G.F. Lee and his associates in the Upper Newport Bay, Orange County, CA area (Lee and Jones-Lee, 1997-1998). A summary of those studies is appended to this report. In addition to urban area stormwater runoff toxicity to *Ceriodaphnia* and mysids, agricultural stormwater and/or commercial runoff/drainage that enters Upper Newport Bay has been found to be toxic to *Ceriodaphnia* and mysids due to unknown causes. Some stormwater runoff into Upper Newport Bay has been found to contain about 10 toxic units of acute *Ceriodaphnia* toxicity.

It can be concluded that OP pesticides represent a significant threat to aquatic life- related water quality - beneficial uses throughout the state. This toxicity is manifested through adverse impacts on certain forms of zooplankton that are potentially important components of larval fish and other aquatic life food.

Regulatory Issues

If the toxicity due to OP pesticides that is routinely found in urban and agricultural stormwater runoff were found in domestic wastewater discharges, the wastewater treatment plant operator and owner would be fined and possibly incarcerated. At this time NPDES wastewater dischargers are required to eliminate the OP pesticide toxicity in the wastewater discharge even though the discharge is to an urban stream that has high levels of OP pesticide toxicity due to NPDES-permitted urban stormwater runoff. This difference in the regulatory approach for the same type of aquatic life toxicity, dependent on whether it is derived from wastewater discharges or stormwater runoff, is the result of the approach that the US EPA adopted for regulating urban stormwater runoff water quality.

NPDES-permitted domestic wastewater discharges must not cause or contribute to exceedance of water quality standards including the narrative standard of no discharge of toxic chemicals in toxic amounts in the receiving waters for the discharge by any magnitude with a frequency greater than once in three years. However, NPDES-permitted urban stormwater runoff water quality managers must control "pollution" of the receiving waters for the runoff to the maximum extent practicable (MEP) using Best Management Practices (BMPs). The US EPA established the requirement that ultimately NPDES- permitted urban stormwater runoff will have to meet the

same discharge requirements as NPDES-permitted wastewater discharges of not causing or contributing to an exceedance of a water quality standard in the receiving water for the stormwater runoff. During some yet to be determined period of time, a BMP ratcheting-down process is to be used in which whenever an exceedance of a water quality standard, including the narrative standard of no toxicity in the stormwater discharges, occurs, the stormwater runoff water quality managers are to implement BMPs to control the violation of the water quality standard. The period of time when this BMP ratcheting-down process is to take place will likely occur over the next five to ten years. Litigation by environmental groups will likely determine the period of time during which stormwater runoff water quality managers and regulatory agencies will have to develop approaches for controlling the OP pesticide-caused toxicity without having the court make this determination.

At this time, the OP pesticide aquatic life toxicity problems are being addressed by a 1997 Management Agency Agreement (MAA) between the Department of Pesticide Regulation (DPR) and the State Water Resources Control Board. DPR has several years to develop appropriate programs to control the OP pesticide aquatic life toxicity problem associated with the use of these pesticides on agricultural crops and in urban areas. At the State Board workshop on the 303(d) listing of impaired waterbodies held in May 1998, there were questions raised about whether the MAA is working and whether it can be expected through the approach being used by DPR focusing on education and voluntary controls will be effective in controlling the OP pesticide toxicity associated with both airborne and waterborne transport from the place of agricultural use to the waters of the state. Based on the authors' experience with pesticide fate and effects and knowledge of agricultural practices, it is unlikely that the voluntary approach will be effective in controlling the OP pesticide toxicity associated with its use on various crops.

One of the issues of concern with respect to regulating OP pesticides is the lack of a water quality criterion for diazinon. While the US EPA has periodically devoted an effort to developing this criterion and in August 1997 announced that the Agency was within a month of publishing a draft criterion, in September 1997, the Agency gave the completion of the diazinon criterion document a low priority with the result that it is now anticipated to be released next fall. Several years ago the US EPA developed a water quality criterion for chlorpyrifos, however this criterion has not been implemented into a state standard. Since chlorpyrifos is not on the Priority Pollutant list, it is not designated as a "toxic chemical" for which water quality standards must be developed by the states. States, however, are not restricted from using the US EPA water quality criterion for chlorpyrifos or, for that matter, another criterion, such as that developed by the California Department of Fish and Game (DFG), in regulating adverse impact to waterbodies. Several years ago, DFG developed water quality criteria for diazinon, chlorpyrifos and several other pesticides using US EPA methodology. The state of California could have used these criteria to more effectively regulate the OP pesticide toxicity that is occurring today.

There are several situations that are going to bring the regulation of OP pesticide aquatic life toxicity associated with urban area and agricultural stormwater runoff/irrigation return water to the forefront for resolution. These include: the Santa Ana Regional Water Quality Control Board (SARWQCB) having to develop a Total Maximum Daily Load (TMDL) for toxics entering Upper Newport Bay in Orange County, CA by 2002. This situation arose from an environmental group filing suit against the US EPA for failing to require that the SARWQCB develop TMDLs

for controlling several 303(d) listed use impairments of Upper Newport Bay, one of which was aquatic life toxicity. The primary cause of the toxicity found in the tributaries of Upper Newport Bay is the OP pesticides, diazinon and chlorpyrifos. Further, the CVRWQCB's recent listing of urban creeks in Sacramento and Stockton and the Delta as 303(d) impaired waterbodies due to OP pesticide-caused toxicity will require that a regulatory program be implemented within a few years to control this toxicity. This program will likely evolve from the implementation of the Bay Protection and Toxic Hot Spot Cleanup Plans at the Regional Board level.

Another factor that could be influential in the regulation of OP pesticide aquatic life toxicity is that the US EPA has indicated that it may require that the San Francisco Regional Water Quality Control Board list urban creeks in the Bay region as 303(d)-listed waterbodies based on OP pesticide toxicity caused by diazinon to *Ceriodaphnia*. If this occurs, it could cause the SF Regional Board to develop a TMDL for control of this toxicity.

A lawsuit filed by an environmental group in the Sacramento area has accelerated the time by which the OP pesticide toxicity issue must be resolved. Within a few years, in accord with the MAA and the litigation, if DPR has not achieved resolution of this matter, the CVRWQCB and State Board will have the responsibility of regulating the OP pesticide aquatic life toxicity

Dr. V. Connor and Dr. T. Mumley have organized an Urban Pesticide Committee that is working to develop a urban area stormwater runoff OP pesticide aquatic life toxicity control program. Thus far this committee is focusing on public education on appropriate use of these pesticides. Based on the authors' experience, the public education approach will not eliminate the urban creek aquatic life toxicity problem since this problem is not necessarily due to misuse of the pesticides. The studies by J. Scanlin in Alameda County and in El Macero by Dr. G.F. Lee have found that urban stormwater runoff toxicity occurs from residential areas where the pesticides have been used in accord with label instructions. This has important implications in developing regulatory programs in that the problem is not just due to inappropriate use but is also due to normal use by residential and commercial applicators in accord with the registered use.

The next section of this discussion is devoted to a suggested approach for implementation of the of the BMP ratcheting down process to ultimately achieve appropriate stormwater runoff toxicity due to OP pesticides and other compounds. While this writeup focuses on the urban creek OP pesticide caused aquatic life toxicity, the approach that is advocated is applicable to agricultural OP pesticides and other pesticides and non - pesticide toxicity problems.

Regulation of Stormwater Runoff Aquatic Life Pesticide Toxicity

Uncertainty exists today on the appropriate approach to follow for regulating urban and agricultural use of pesticides in order to protect stormwater runoff receiving water aquatic life from pesticide-caused toxicity. This problem arises in part from the fact that animal and plant pests are significantly adverse to urban dwellers' structures and properties. Further, pesticides are a key component of agricultural crop production. Pesticides, including herbicides, can be effective for controlling the adverse impacts of urban and agricultural pests. However, current pesticide regulatory approaches associated with pesticide registration and use labeling do not

necessarily eliminate pesticide-caused toxicity to some forms of aquatic life in stormwater and fugitive (irrigation) water runoff from residential, commercial and agricultural properties.

The key issue that needs to be addressed in developing a regulatory approach for urban and agricultural OP pesticide aquatic life toxicity is the water quality significance of this toxicity to the beneficial uses of the receiving waters for the stormwater runoff. If OP pesticide toxicity directly affected fish or other forms of aquatic life of primary concern to the public, then the control of this toxicity would be required. However, because of the limited number of types of organisms potentially impacted and the uncertainty of their importance to higher trophic level organisms of concern to the public, the water quality significance of this toxicity is unknown.

At this time, the OP pesticide aquatic life toxicity associated with urban stormwater runoff is of concern with respect to potential adverse impacts to certain zooplankton species (mysid-like and *Ceriodaphnia*-like organisms). While there is no doubt that certain zooplankton populations are adversely impacted by urban area and agricultural stormwater runoff and fugitive/excess irrigation waters OP pesticide-caused aquatic life toxicity, it is unknown at this time whether this toxicity is significantly adverse to fish populations through impacting the availability of zooplankton food for larval fish and other organisms that are key components of the food web. This is the critical issue that must be evaluated through site-specific studies which assess the spectrum of zooplankton and other organisms that are adversely impacted by OP pesticide toxic pulses that occur with each stormwater runoff event.

Once the types of zooplankton impacted by OP pesticides are known, then site-specific evaluations need to be made in the receiving waters for the urban stormwater runoff which determine the magnitude of zooplankton and other organism population impacts and the significance of these impacts on higher trophic level organisms through restrictions in their food supply. Of particular concern is whether reducing or eliminating zooplankton populations with sensitivities similar to those of *Ceriodaphnia* and mysids to OP pesticide aquatic life toxicity for short periods of time sufficiently restricts larval fish and other aquatic life food to significantly impact the water quality and ecological characteristics of a waterbody so as to cause regulatory agencies to significantly curtail, if not totally ban, OP pesticide use in urban areas and agriculture where that use leads to significant adverse impacts on the beneficial uses of the receiving waters for the stormwater runoff.

The current risk assessments for diazinon and chlorpyrifos toxicity that have been developed by pesticide companies and others have not adequately addressed many of the key issues that need to be addressed in order to determine whether OP pesticides present in urban stormwater runoff at potentially toxic concentrations are significantly adverse to the beneficial uses of the receiving waters for the stormwater runoff as well as the aquatic and terrestrial ecosystems associated with these waters. At this time, there is a poor understanding of the full range of organisms that are impacted by OP pesticide toxicity in receiving waters for urban stormwater runoff. Further, the actual zooplankton and larval fish population dynamics associated with urban stormwater runoff pesticide toxicity have not been adequately investigated. The macrocosm studies which have been used to claim that the OP pesticide toxicity is of limited significance to fish populations do not provide adequate, reliable information on this issue that can be extrapolated to the range of

conditions where there is appropriate concern about OP pesticide aquatic life toxicity associated with urban and agricultural stormwater runoff.

Need for Regulatory Guidance

There is need to provide guidance to regulatory agencies, commerce, industry, environmental groups and the public on how to determine whether the OP pesticide aquatic life toxicity associated with urban stormwater runoff and fugitive irrigation runoff is of sufficient magnitude, duration, and areal extent to adversely impact zooplankton and other organisms that are essential components of larval and other organism food. It is suggested that the State of California Water Resources Control Board and the Regional Boards appoint an expert panel to develop the guidance needed to assess, on a site-specific basis, the water quality significance of urban stormwater runoff OP pesticide aquatic life toxicity. This expert panel would develop guidance on the types of site-specific studies that are needed to define the water quality - use impairment significance of urban and agricultural stormwater runoff-associated OP pesticide aquatic life toxicity. The overall approach should follow the development of information to formulate a site-specific ecological and water quality risk assessment associated with OP pesticide use in urban and rural areas.

The risk assessment information should provide the technical base that regulatory agencies can use to develop pesticide aquatic life toxicity control programs without significant unnecessary restriction on pesticide use beyond that needed to protect the designated beneficial uses of receiving waters and downstream waters for urban area stormwater runoff. This information, when coupled with the other components of the pesticide regulatory process, will ultimately lead to an appropriate balance between the use of pesticides in the urban environment and their impacts on the beneficial uses of receiving waters for urban area stormwater runoff.

There will be need for substantial, expensive multi-year laboratory and field studies to provide the technical information base needed to properly manage urban area stormwater runoff OP pesticide aquatic life toxicity. It is suggested that the expert panel formulate an approach which would specifically address the mechanism for developing the funds that are needed to conduct the necessary laboratory and field studies. The funding for these studies should be derived from the pesticide companies, pesticide formulators, applicators and the public who use pesticides for urban pest control, i.e. those who benefit from pesticide use. Failure to provide the necessary funding should lead to severe restrictions on the use of OP pesticides in the urban environment that leads to stormwater and fugitive/excess irrigation water toxicity in the receiving waters for the runoff. The burden of proof on the appropriate continued use of urban and agricultural pesticides should be shifted from the environment to those who wish to sell, apply and use pesticides in urban and agricultural areas where stormwater runoff from the areas of use leads to receiving water toxicity.

The implementation of the OP pesticide aquatic life toxicity program should be through a watershed-based stakeholder process where, under the leadership of an executive committee of the stakeholders, the regulatory and other issues are reviewed and a consensus is developed pertinent to the use and the associated impacts of such use. The stakeholders' executive committee should develop the necessary funding from pesticide manufacturers, formulators and

users to appoint a technical leader who would coordinate, shepherd, stimulate, and serve as a technical resource to the stakeholder executive committee. The technical leader, with the assistance of an appointed consulting team, should develop a report on data/information gaps, and develop a monitoring/evaluation program to fill data gaps. The evaluation of OP pesticide-caused toxicity must be conducted within the framework of the total aquatic life toxicity of the waterbody of concern to evaluate the potential improvements in the waterbody's beneficial uses that will arise from restricting the use of OP pesticides.

In the event of disagreements between experts on technical issues related to OP pesticide aquatic life toxicity, a full public interactive peer review of the issues should be conducted where there is an interactive opportunity for those concerned to support their views on technical issues and to appropriately discuss the technical validity of other views. Full public interactive peer review will likely require several meetings of the executive committee to review the issues in dispute.

The adoption of the suggested approach can lead to an appropriate regulatory approach for protecting the designated beneficial uses of receiving waters for urban area and agricultural stormwater runoff that are potentially impacted by the use of OP pesticides. While this approach focuses on the urban area stormwater runoff OP pesticide aquatic life toxicity issues, it is equally applicable to OP and other pesticides, as well as non-pesticide - caused aquatic life toxicity associated with stormwater runoff and/or wastewater discharges.

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Summary of Upper Newport Bay Tributary Aquatic Life Toxicity Testing Results

Presentation to Cal EPA
Department of Pesticide Regulation

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May 28, 1998

Background

As part of an Evaluation Monitoring Demonstration Project, exceedances of US EPA worst case Water Quality Criteria/Standards for several potentially toxic heavy metals and organochlorine pesticides/PCBs have been found in tributary waters of Upper Newport Bay, Orange County, CA. Also, an indication of aquatic life toxicity of unidentified causes was found in several samples of Upper Newport Bay tributary waters in the early 1990s.

A highly directed monitoring/evaluation program to evaluate whether the tributary waters to Upper Newport Bay are toxic to aquatic life was initiated. This program used a focused event-based monitoring program to determine whether San Diego Creek waters entering Upper Newport Bay are toxic to the US EPA standard three species test organisms. In accord with Evaluation Monitoring procedures, if toxicity is found, determine its cause, water quality significance and the source of the toxicants. Develop control programs for toxicants that cause significant water quality use impairments in San Diego Creek and/or Upper Newport Bay.

Background to Developing the Evaluation Monitoring Demonstration Project

Evaluation Monitoring vs. Conventional "Water Quality" Monitoring

- Conventional monitoring
  - Suite of chemicals, several storms - Try to extrapolate to water quality impacts
    - Heavy metals: attempt to extrapolate chemical concentration to toxicity
  - Not reliable for assessing the water quality impacts
  - Not a technically valid base for developing BMPs

- Evaluation monitoring focuses on defining and management of real water quality use impairments-i.e. toxicity, bioaccumulation, sanitary quality, excessive fertilization, etc.
  - If toxic, assess duration, extent and magnitude of toxicity to key organisms, determine cause and sources

  - If excessive bioaccumulation of hazardous chemicals in fish tissue, determine source(s)

Current Water Quality/Use Impairment Problems in Upper Newport Bay and San Diego Creek

Report: "Review of Existing Water Quality Characteristics of Upper Newport Bay, Orange County CA and its Watershed," June, 1997

Beneficial uses impaired
- Excessive fertilization

Siltation-sediment accumulation
Sanitary quality-contact recreation and shellfish harvesting
Low dissolved oxygen
Litter
Sediment quality - toxicity?
Potentially toxic constituents in water column
- Excessive heavy metals
- Toxicity-1990-91
- Need study

San Diego Creek Aquatic Life Toxicity Studies

Test organisms
- *Ceriodaphnia dubia*, a freshwater zooplankton
- *Pimephales promelas* - Fathead minnow larvae -fish
- *Selenastrum capricornutum* -algae
- *Mysidopsis bahia*, a marine zooplankton
  - Mysids more sensitive to chlorpyrifos than *Ceriodaphnia*

Testing procedure - US EPA standard tests
- Dilution series - PBO
  - Establishes total magnitude of toxicity in sample
    - Screens for organophosphate pesticides
- ELISA: diazinon and chlorpyrifos
- Dual-column gas chromatographic procedures

Report: "Aquatic Life Toxicity in Stormwater Runoff to Upper Newport Bay, Orange County, California: Initial Results," June (1997)

Toxicity Testing Results
- Fall 1996 -San Diego Creek at Campus Dr. had about 10 acute toxicity units (TUa) to *Ceriodaphnia* toxicity during stormwater runoff events
  - Non-toxic between storms
  - No toxicity to fathead minnow larvae or alga

Fall 1997-Four stormwater runoff events sampled at San Diego Creek Campus Drive September 25, 1997, November 13 and 30 December 6, 1997 - Toxicity pattern observed during fall 1996 occurred in fall 1997

3 to 10 *Ceriodaphnia* (TUa) - Dilute up to 10 times with non-toxic water, still toxic to *Ceriodaphnia*

Also toxic to mysids

General Findings

- Higher levels of toxicity associated with greater magnitude runoff events
- Toxicity does not occur during base flow (groundwater) conditions in San Diego Creek
- Toxicity apparently present throughout stormwater runoff event at about the same concentrations- no first flush characteristics
- Rainfall sample in Irvine, CA during December 6, 1998 contained diazinon (13 ng/L) and chlorpyrifos (23 ng/L) at non-toxic concentrations
- Organophosphate pesticides present in San Diego Creek tributaries at about same concentrations as at Campus Dr.
- Diazinon and chlorpyrifos-caused toxicity likely due to urban area use
- Toxicity to Ceriodaphnia also likely due to agriculturally used pesticides-methomyl and some unidentified constituent (s)
- Approximately half of toxicity found caused by unidentified constituents

Spring 1998

Large amounts of rainfall in mid winter - did not sample

No toxicity in San Diego Creek base flow on March 24,1998 on day before a storm

Santa Ana Delhi Channel toxic to fathead minnow larva in March 24, 1998 prestorm sample

March 25, 1998 storm - small amount of runoff - toxicity to Ceriodaphnia in Peters Canyon Wash (PCW) at Barranca which is a San Diego Creek tributary, >10 TUa

Less toxicity in San Diego Creek as it enters Upper Newport Bay than in PCW at Barranca - Diluted by main flow of San Diego Creek

Some diazinon in San Diego Creek - no measurable chlorpyrifos

TIE not able to identify cause of toxicity - toxic constituents cannot be eluted from conventional TIE fractionation column. Dr. Jeff Miller of Aqua Science has developed special column which can fractionate unknown toxic components. Samples of fractionated samples with unknown toxicity being sent for GC/MS

Santa Ana Delhi Channel toxic to Ceriodaphnia in March 25, 1998 storm runoff

May 5, 1998 storm - San Diego Creek at Campus 100% mortality of Ceriodaphnia in 48 hours

0% mortality with PBO

Santa Ana Delhi Channel non toxic to Ceriodaphnia

May 13, 1998 storm- highly toxic (>10 TUa) to Ceriodaphnia in San Diego Creek at Campus Drive apparently due to diazinon (375 ng/L) and chlorpyrifos (57 ng/L) and unknown

constituent (s). Also toxic to Mysids. PBO not effective in eliminating toxicity. Also highly toxic PCW at Barranca

Conclusion: Based on two years of selected monitoring of San Diego Creek waters, there is a potentially significant aquatic life toxicity problem in San Diego Creek and Upper Newport Bay that needs to be evaluated with respect to its potential impacts on the beneficial uses of both of these waterbodies.

Future Studies - Identification of the Cause and Significance of Aquatic Life Toxicity

Toxicity studies: emphasis on determining the water quality-use impairment significance of the aquatic life toxicity

Detailed toxicity investigation evaluation (TIEs)

Substantial *Ceriodaphnia* toxicity cannot be accounted for by diazinon and chlorpyrifos

Need more extensive TIE studies

Full US EPA Phase III TIE procedure can cost on the order of $10,000

May not be possible to identify cause of toxicity through TIEs

Use forensic studies combined with TIEs to track the source of the unknown toxic components to the origin - obtain assistance of Orange County Agricultural Commissioner to identify pesticides used on agricultural crops in Peters Canyon Wash watershed

Water Quality Significance of Ceriodaphnia and Mysid Toxicity

Emphasis of future Upper Newport Bay studies should be devoted to assessing water quality significance of San Diego Creek aquatic life toxicity on beneficial uses of Upper Newport Bay

Previously, toxic conditions considered sufficient to initiate regulatory activity - SARWQCB to develop TMDL for "toxics" in San Diego Creek and Upper Newport Bay by 2002 - not tied to a specific chemical

Current SARWQCB Basin Plan narrative objective - "no toxics in toxic amounts" must be ultimate goal of TMDL until Basin Plan amended.

SWRCB's fall 1997 proposed approach for implementing California Toxics Rule, under "Chronic Toxicity Objective"

"Surface waters outside of any allowed mixing zones shall be free from lethal or Sublethal toxicity at levels which impair designated aquatic life beneficial uses."

Initial phase of water quality impact evaluation devoted to assessing water quality significance/use impairment of Upper Newport Bay: rate of dilution of Creek waters with Bay waters Critical to evaluation of water quality significance of toxic pulses

San Diego Creek waters during stormwater runoff event expected to float as lens on top of saline Bay waters

Aquatic life brought into Bay via San Diego Creek will be killed by salinity

Characteristics of freshwater lens/mixing zone depend on
- Tide stage
- Magnitude and duration of runoff event
- Other characteristics of Creek discharges. i.e. temperature

Mixing and transport processes
- Develop descriptions of mixing profiles (vertical and longitudinal): freshwater input diluted by marine waters

- Possible that San Diego Creek waters could be diluted 20-fold by Bay waters and still be toxic to some marine organisms

Specific sampling to be conducted within Bay during stormwater runoff event to determine if predicted dilution of toxicity and measured toxicity matches what is found in Bay

Organize expert panel of individuals to develop guidance on determining what constitutes excessive toxicity
- Direct and indirect toxicity to important species
  - Korean Shrimp (adult) in Sacramento River Delta reported to be killed by chlorpyrifos at 10 ng/L

How much effort should be directed toward protecting San Diego Creek planktonic organisms from organophosphate pesticide toxicity?
- Short travel time in creek and Death in Bay due to salinity

San Diego Creek Watershed Studies
- Focus on determining specific sources of toxicity and toxic components
  - Sampling of each of the major tributaries of San Diego Creek
    - Twice (early and late in runoff event)
- Sample stormwater runoff where organophosphate pesticides applied to residential properties to determine
  - Magnitude of runoff of pesticides during stormwater runoff event, and in fugitive irrigation waters
- Agricultural runoff sampling to determine sources of toxicity
  - Work with Agricultural Commissioner and others
- Nurseries in Upper Newport Bay watershed possible source of unknown "pesticide" toxicity?
- Atmospheric transport of organophosphate pesticides from agricultural use?

Urban Stormwater Runoff OP Pesticide Toxicity Issues
- Urban stormwater runoff in San Francisco Bay area, Sacramento, Stockton, Davis, El Macero, Upper Newport Bay watershed communities, Los Angeles area, and San Diego all toxic to Ceriodaphnia - apparently due to diazinon and chlorpyrifos
  - Violation of Basin Plan objective of no toxicity

Key issue that must be resolved for the development of appropriate urban pesticide use-management program is the water quality significance of this toxicity

Pesticides are useful to the urban-dweller - Must develop an approach to protect appropriate use and beneficial uses of receiving water for stormwater runoff

Residential use of OP pesticides in accord with label can lead to stormwater receiving-water toxicity

If toxicity found to be a significant cause of aquatic life related beneficial uses of Upper Newport Bay will have to restrict use and /or reformulate to prevent stormwater and fugitive water runoff.

Use other pesticides as alternatives to diazinon and chlorpyrifos

Catalyst - Propetamphos toxicity to *Ceriodaphnia* and mysids unknown

Upper Newport Bay Sediment Toxicity Issues

EMAP and WRCB BPTCP 1994 sediment, chemical characteristics and toxicity studies show low levels of toxicity

Chlorpyrifos in Upper Newport Bay sediments near Jamboree Road

Toxicity unknown

Sediment toxicity issues low priority for future work

Bioaccumulation of Hazardous Chemicals

WRCB Toxic Substances Monitoring Program (TSM) data for fish and shellfish taken from Upper Newport Bay and San Diego Creek show edible aquatic organism tissue contains excessive concentrations of

Several chlorinated hydrocarbon pesticides, PCBs, and Mercury

Summer 1997, SARWQCB TSM. sampled San Diego Creek and Bay fish

Data scheduled to be available in summer 1998

Define major gaps in information

Insufficient sensitivity in analytical procedures for many US EPA Region 9 proposed guideline values for human consumption of fish

Dioxin content of San Diego Creek and Upper Newport Bay fish and shellfish unknown

Does excessive bioaccumulation in San Diego Creek fish represent threat to human health? Are fish used as human food?

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