City of Stockton Urban Stormwater Runoff Aquatic Life Toxicity Studies

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with the assistance of

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- Summary Results of Aquatic Life Toxicity Studies on Stockton Stormwater Runoff 1994 – 1999
- Conclusions & Recommendations from These Studies
- Development of TMDL to Control Aquatic Life Toxicity in Urban Stormwater Runoff

Background

- In 1994, Dr. Val Connor of CVRWQCB Initiated Monitoring of City of Stockton Sloughs during Stormwater Runoff Events
  - Supported by US EPA and CVRWQCB
- 1995–1999 Testing Continued by DeltaKeeper
  - Supported by DeltaKeeper and CALFED
- Samples Tested by UC-Davis Toxicology Laboratory for Toxicity to:
  - Zooplankton *(Ceriodaphnia)*
  - Fathead minnow larvae *(Pimephales promelas)*
  - Algae *(Selenastrum)*

More Than 160 Toxicity Tests Performed

Review of the City of Stockton Urban Stormwater Runoff Aquatic Life Toxicity Studies Conducted by the CVRWQCB, DeltaKeeper and the University of California, Davis, Aquatic Toxicology Laboratory between 1994 and 2000

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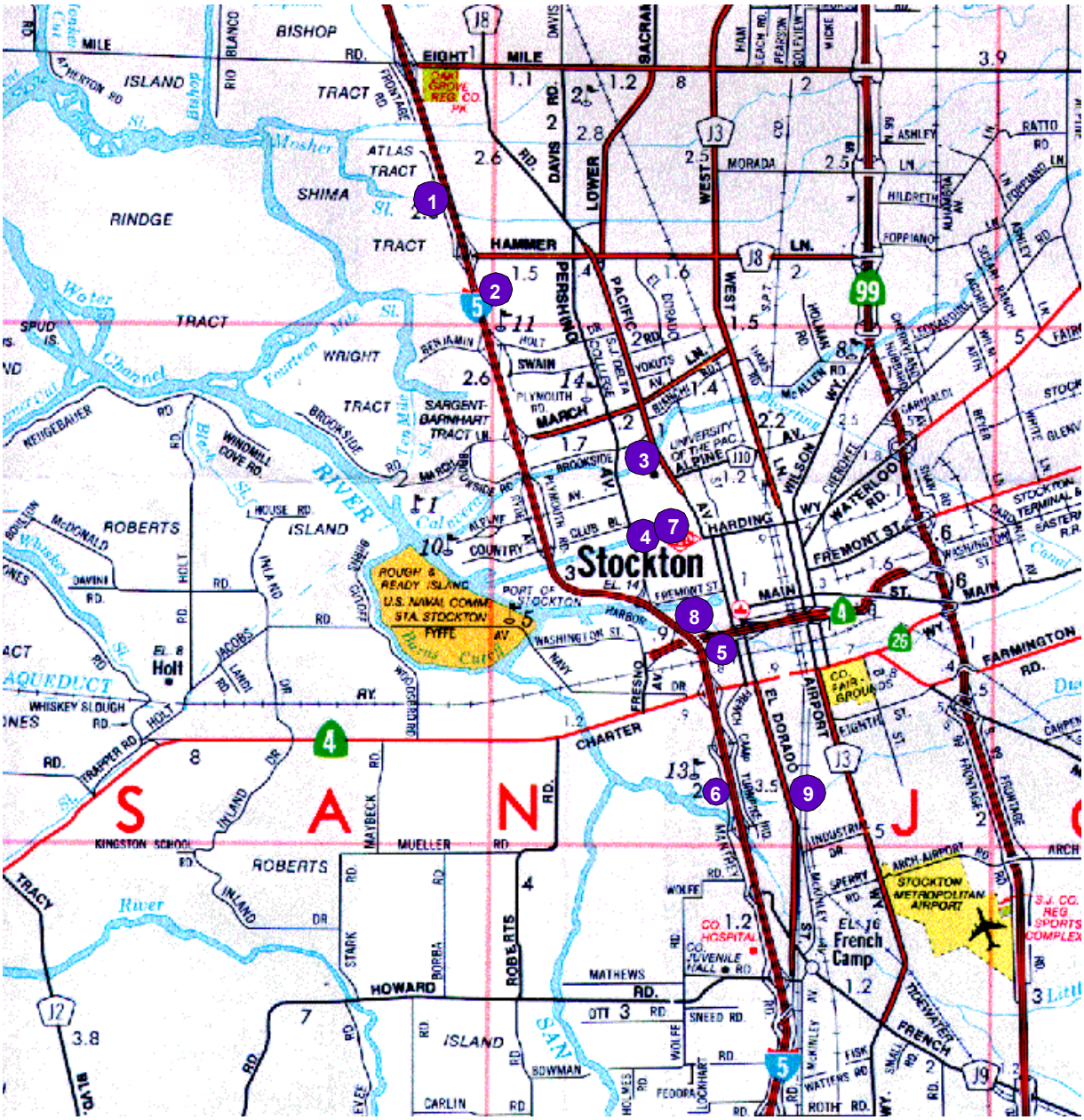
Synopsis

Beginning in 1994, the Central Valley Regional Water Quality Control Board (CVRWQCB) under Dr. Val Connor's leadership with support of a US EPA grant and with the assistance of the University of California, Davis, Aquatic Toxicology Laboratory (UCD-ATL), initiated a study of aquatic life toxicity in the city of Stockton's sloughs/rivers during stormwater runoff to these waterbodies. In 1996, Bill Jennings, the DeltaKeeper continued the studies through sample collection and funding of toxicity testing. CALFED made grant support available in 1998-1999 to the DeltaKeeper to conduct aquatic life toxicity studies in the Sacramento-San Joaquin River Delta. The sampling of the Delta included several locations within the city of Stockton sloughs/rivers.

In these studies, samples of stormwater runoff were obtained from Mosher Slough, Five Mile Slough, Calaveras River, Walker Slough-Duck Creek and the Smith Canal. Smith Canal and Five Mile Slough receive stormwater runoff only from the city of Stockton. Mosher Slough, Calaveras River and Walker Slough also at times receive stormwater runoff from agricultural areas and agricultural return (tailwaters) upstream of the city of Stockton. All of these waterbodies discharge to the Sacramento-San Joaquin River Delta and are tidal freshwater within the city of Stockton with a one- to three-foot tide. For some areas of the City, dry weather flow and stormwater runoff in the City's storm sewers is pumped to the sloughs/rivers. Approximately 160 aquatic toxicity tests and associated chemical measurements of stormwater runoff and dry weather flow were conducted from 1994-1999. This report presents the data obtained in the studies and summarizes the results.

All samples of the city of Stockton sloughs/rivers collected in these studies during stormwater runoff events were toxic to *Ceriodaphnia*, a freshwater zooplankton. Typically 1 to 2 TUa of *Ceriodaphnia* toxicity was found with some samples containing about 4 TUa of acute toxicity to *Ceriodaphnia*. In general, dry weather flow conditions were nontoxic to *Ceriodaphnia*. The stormwater runoff samples and dry weather flow samples were nontoxic to the fathead minnow larvae and the alga, *Selenastrum*



Stockton Slough Sampling Sites

1 Mosher Slough - Mariner's Drive bridge at I-5
2 Five-Mile Slough - at Plymouth Road bridge
3 Calaveras River - at Woods Bridge, north of UOP campus
4 Smiths Canal - at Pershing Avenue bridge
5 Mormon Slough - at Lincoln Street bridge
6 Walker Slough - at Manthey Road bridge and I-5 (Van Buskirk Park)
7 Smiths Canal - at Yosemite Street
8 Mormon Slough - at Turning Basin
9 Walker Slough - upstream from confluence with Duck Creek

Example Data
Stockton Urban Run-off
10/5/94 & 10/6/94
8-day Ceriodaphnia Test[1,2]

Treatment	Reproduction (neonates/adult)		Mortality (%)
	mean	std error	
Dilute EI	38.6	1.5	0.0 [P]
SSEPAMH	28.7	2.3	0.0
Five-Mile Slough	0.0	0.0	100 (2)
Calaveras River	1.2	0.6	100 (4)
Mosher Slough	0.0	0.0	100 (2)
Walker Slough	14.9	1.5	100 (7)

Conclusions

- Stormwater Runoff to Stockton Sloughs Investigated during 1994–1999 Caused Sloughs to Be Toxic to *Ceriodaphnia*
- Typically 1 to 2 TUa (acute toxic units) Present in Stockton Sloughs during Stormwater Runoff Event
- Concentrations of Diazinon & Chlorpyrifos in Stockton's Sloughs/Rivers & Other Waterbodies Frequently Exceeded CA DFG Recommended Criteria Following Stormwater Runoff Events. Exceedance Would Cause Waterbodies to Be in Violation of TMDL Goals (Numerically Equal to Criteria) for Control of Aquatic Life Toxicity Caused by These Pesticides
- Samples Collected Day after Stormwater Runoff Event Were, in General, Non-Toxic & Had Low Levels of OP Pesticides
- Stormwater Runoff to These Waterbodies Generally Did Not Cause

Conclusions (cont'd)

- Based on Toxicity Identification Evaluations (TIEs), PBO, & ELISA Testing, Diazinon Was Chemical Primarily Responsible for Observed Toxicity. Some Samples Had Sufficient Concentrations of Chlorpyrifos to Contribute to Toxicity Found
- Based on Limited TIE Studies Using EDTA to Complex Heavy Metals, Heavy Metals Do Not Appear to Contribute to Aquatic Life Toxicity Found
- Some Indication of Possible Pyrethroid Pesticide Toxicity as Indicated by PBO-Enhanced Toxicity
- Aquatic Life Toxicity Found in City of Stockton Stormwater Runoff Similar to That Found in Urban Stormwater Runoff in San Francisco Bay Region, Sacramento Area, Orange County, CA, Los Angeles, & San Diego.
- Stormwater Runoff-Associated Toxicity Has Caused Several Stockton Sloughs to Be Classified

Recommendations for Future Work

- Need to Evaluate Water Quality/Ecological Significance of Periodic, Toxic Pulses Associated with Stormwater Runoff Events in City of Stockton on Aquatic Life Resources of Sloughs/Rivers & Nearby Delta. Slough/River Backwater Areas Could Be Important Nursery Grounds for Delta Fish That Are Being Adversely Impacted by Current OP Pesticide-Caused Aquatic Life Toxicity
- US EPA Has Announced Phase-Out Use of OP Pesticides Diazinon & Chlorpyrifos in Residential Areas during 2001 (Chlorpyrifos) and by 2005 (Diazinon). This Means There Will Be Significant Decrease in, or Elimination of, Aquatic Life Toxicity Caused by Residential Use of These Pesticides in Residential Areas in Stockton, within a Few Years.
- Since Phase-Out of Residential Use of Diazinon & Chlorpyrifos Will Result in Use of Other Pesticides That Have the Potential to Be Present in Stormwater Runoff, Important to Determine What Pesticides Are Being Used on Residential Properties, Amounts Used, How & Where They Are Being Applied, and Concentrations & Toxicity in Stormwater Runoff.
- Need to Understand How Use of Pesticides in Residential Areas for Termite and Ant Control, and Lawn & Garden Pest Control Leads to Stormwater Runoff That Is Toxic to *Ceriodaphnia* & Other Forms of Aquatic Life

TMDL Development for Aquatic Life Toxicity Caused by OP Pesticides Diazinon & Chlorpyrifos

Components of TMDL

- **Technical TMDL**
  - Problem Statement
  - Numeric Targets Report
  - Source Analysis
  - Linkage Analysis
  - TMDL Report
- **Implementation Plan**
  - Allocation of Responsibility among Sources
  - Funding of Source Control/Management Program
  - Monitoring of Effectiveness of Management Plan

TMDLs Normally Implemented in Phased Approach Using Adaptive Management Plan for Each Phase

Regulatory Requirements

In Accordance with US EPA Clean Water Act Requirements, the CVRWQCB Has Adopted a Basin Plan Objective of No Toxicity in Ambient Waters. CVRWQCB (1998) Stated,

*"**Toxicity***

All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life."

Water Quality Criteria

Freshwater Criteria	Acute CMC (1-hr) (ng/L)	Chronic CCC (4-day average) (ng/L)
Diazinon	80	50
Chlorpyrifos	20	14
Saltwater Criteria	**Acute CMC (1-hr) (ng/L)**	**Chronic CCC (4-day average) (ng/L)**
Chlorpyrifos	20	9

Source: Siepmann, S. and Finlayson, B., *"Water Quality Criteria for Diazinon and Chlorpyrifos,"* California Department of Fish and Game, Administrative Report 00-3, Rancho Cordova, CA (2000).

Summary of Water Quality Targets for TMDL

Method	Criterion (ng/L)
US EPA Method as Used by US EPA	Acute: 90 Chronic: NA
US EPA Method as Used by CDFG	Acute: 80 Chronic: 50
Site-Specific Objectives	NA*
Probabilistic Ecological Risk Assessment: All Organisms	Acute 5th Percentile: 1,117 Acute 10th Percentile: 3,710
Probabilistic Ecological Risk Assessment: Arthropods	Acute 5th Percentile: 195 Acute 10th Percentile: 483
Mesocosm/Microcosm: Invertebrates LOECs	Mesocosm: 8,400 Microcosm: 9,100
Mesocosm/Microcosm: Cladocerans LOECs	Mesocosm: 2,300
Ceriodaphnia "No Effects" Level Method	NA

Source: SRWP, "Water Quality Management Strategy for Diazinon in the Sacramento and Feather Rivers," Sacramento River Watershed Program, Organophosphate Focus Group, May (2001).

* Could conduct site-specific studies to demonstrate impact of toxic pulses caused by stormwater runoff on the beneficial uses of waterbodies receiving the runoff.

Urban Stormwater Runoff Toxicity: Future Issues

- Shift from OP to Other Pesticides
  - Likely Pyrethroid Pesticides
    - Toxicity Is as Great, or Greater, for Zooplankton
    - Also Highly Toxic to Fish
- Lack Reliable Analytical Methods for Pyrethroid Pesticides
- Pyrethroid Pesticides Have Greater Affinity to Solids
  - Less Transport?
- Need Funds for Monitoring Effects of Change from OP to Pyrethroid or Other Pesticides on Aquatic Life Toxicity in Urban Waters
- Evaluate Water Quality Significance of Toxic Pulses in Urban Stormwater Runoff

Pro-Active Approach

- Since US EPA OPP and CA DPR Pesticide Registration Approaches Do Not Require Evaluation of the Potential for Stormwater Runoff to Lead to Aquatic Life Toxicity in Receiving Waters, Need Pro-Active Approach to Evaluate Where Pesticides Are Applied, Whether Stormwater Runoff Causes Aquatic Life Toxicity in the Waters Receiving the Runoff
- See Lee, G.F., and Jones-Lee, A., *"Pro-Active Approach for Managing Pesticide-Caused Aquatic Life Toxicity,"* Report of G. Fred Lee & Associates, El Macero, CA (2000).