Total Maximum Daily Loads to Address Organophosphate Pesticides and Aquatic Toxicity Impairments within the Lower Salinas River Watershed, Monterey County, California

Problem Statement

The lower Salinas River watershed encompasses an area of approximately 405 square miles in northern Monterey County. The watershed extends from approximately the City of Gonzales north to Monterey Bay and the Pacific Ocean and it contains two major drainages, the lower Salinas River and the Salinas Reclamation Canal. Tributaries to the lower Salinas River include Chualar Creek, Esperanza Creek, Quail Creek, Toro Creek, and Blanco Drain. Near the coastline, the lower Salinas River forms into the Salinas River Lagoon which may drain into the ocean during rare high flow or "breach; conditions or into the Old Salinas River and Moss Landing Harbor. Tributaries to the Salinas Reclamation Canal include Alisal Creek, Natividad Creek, Gabilan Creek, Santa Rita Creek, Alisal Slough, Espinosa Slough, and Merritt Ditch. The downstream segment of Salinas Reclamation Canal forms into Tembladero Slough which then drains into the Old Salinas River and Moss Landing Harbor. Several streams within the lower Salinas River watershed are contained on the federal Clean Water Act section 303(d) List of impaired waterbodies (303(d) List) due to one or more of the following conditions: excessive concentrations of chlorpyrifos, diazinon, malathion (organophosphate pesticides), and toxicity. Table 1 identifies the waterbodies and associated impairment(s).

Table 1. Organophosphate pesticide and toxicity impaired waterbodies on the 303(d) List.

Water Body Name	Impairment
Alisal Creek	toxicity
Alisal Slough	diazinon, toxicity
Blanco Drain	chlorpyrifos, diazinon, toxicity
Chualar Creek	chlorpyrifos, diazinon, malathion, toxicity
Espinosa Lake	chlorpyrifos, diazinon,
Espinosa Slough	diazinon, malathion, toxicity
Gabilan Creek	toxicity
Merritt Ditch	diazinon, toxicity
Moro Cojo Slough	toxicity
Moss Landing Harbor	chlorpyrifos, diazinon
Old Salinas River Estuary	chlorpyrifos, diazinon
Natividad Creek	diazinon, toxicity
Old Salinas River	chlorpyrifos, diazinon, toxicity
Quail Creek	chlorpyrifos, diazinon, malathion, toxicity
Salinas Reclamation Canal	chlorpyrifos, diazinon, malathion, toxicity
Salinas River (lower, estuary to near Gonzales Rd)	chlorpyrifos, diazinon, toxicity
Salinas River Lagoon (North)	chlorpyrifos, toxicity
Tembladero Slough	chlorpyrifos, diazinon, malathion, toxicity

Water quality management goals of this TMDL project are to rectify 303(d) List impairments by reducing and/or eliminating organophosphate pesticide concentrations and preventing toxic conditions within the watershed.

Numeric Targets

Numeric targets are water quality targets used to ascertain when and where water quality objectives are achieved, and hence, when beneficial uses are protected. Note that the pesticide and toxicity water quality objectives are narrative objectives and the numeric targets proposed for these TMDLs are used to interpret the narrative objectives. Water column numeric targets for the organophosphate pesticides addressed in this TMDL are summarized in Table 2.

Table 2. Water column numeric targets for organophosphate pesticides.

Compound	CMC [A] (ppb)	CCC [B] (ppb)	Reference
Chlorpyrifos [C]	0.025	0.015	CDFW, 2000
Diazinon [C]	0.16	0.10	CDFW, 2000
Malathion [C]	0.17	0.028	Faria et. al., 2010

[A]. CMC – Criterion Maximum Concentration or acute (1- hour average). Not to be exceeded more than once in a three-year period

[B]. CCC – Criterion Continuous Concentration or chronic (4-day (96-hour) average). Not to be exceeded more than once in a three-year period

[C]. A toxicity ratio is used to account for the additive nature of these compounds as contained in the proposed additive toxicity numeric targets presented below.

Chlorpyrifos, diazinon, and malathion have the same mechanism of toxic action and exhibit additive toxicity to aquatic invertebrates when they co-occur (Bailey et al., 1997; CDFW, 2000). Mixtures of compounds acting through the same mechanism suggest there is no concentration below which a compound will no longer contribute to the overall toxicity of the mixture (Deneer et al., 1988). Therefore, the total potential toxicity of co-occurring chlorpyrifos, diazinon, and malathion needs to be assessed, even when one or more of their individual concentrations would otherwise be below thresholds of concern.

The additive toxicity numeric target, when two or more organophosphate pesticides are present in the water column, is defined as the concentration of chlorpyrifos divided by the numeric target for chlorpyrifos plus the concentration of diazinon divided by the numeric target for diazinon plus the concentration of malathion divided by the numeric target is equal to or less than one. Figure 1 depicts the equation for the additive toxicity numeric target.

$$\frac{C\ Chlorpyrifos}{NT\ Chlorpyrifos} + \frac{C\ Diazinon}{NT\ Diazinon} + \frac{C\ Malathion}{NT\ Malathion} = S;\ S \leq 1$$

Where:
C = the concentration of a pesticide measured in the receiving water.
NT = the numeric target for each pesticide present.
S = the sum; a sum exceeding one (1.0) indicates that beneficial uses may be adversely affected.

Figure 1. Equation for additive toxicity numeric target (S≤1).

Numeric targets for toxicity include the organophosphate pesticides numeric targets contained above, as well as numeric targets for aquatic toxicity testing as described herein. Any invertebrate species and acceptable test methods (as defined by regulatory Orders or ambient monitoring study designs) shall be used to assess whether the toxicity numeric target is achieved. Assessments will be conducted with receiving water(s) sampled at key indicator sites, which will be defined in proper sampling plans with quality assurance and quality controls consistent with California Surface Water Ambient Monitoring Program (SWAMP) protocols.

Toxicity to invertebrates shall be tested using chronic or acute toxicity tests. It is recommended (not required) that toxicity determinations be based on a comparison of the test organisms' response to the receiving water sample compared to the control using the Test of Significant Toxicity, also referred to as the TST statistical approach. If a sample is declared "fail" (i.e., toxic), then the target is not met and additional receiving water sample(s) should be collected and evaluated for this specific receiving water to determine the pattern of toxicity and whether a toxicity identification evaluation, also referred to as a TIE, needs to be conducted to determine the causative toxicant(s). Other toxicity test methods, where determined appropriate for use, may be used to determine attainment of the numeric target. Using these methods, significant toxicity is determined for samples where: 1) the statistical test confirms significant differences in test organism when compared to the control sample, and 2) a test organism performance is more than 20% lower in the sample than in the control sample.

The aquatic toxicity numeric targets for this TMDL are stated as the following:

> No significant toxic effect to the survival or sublethal (i.e., growth, reproduction, etc.) test endpoint.

This aquatic toxicity numeric target is consistent with the Basin Plan narrative water quality objective which states, in part:

> *"All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density,*

growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board.

Under Development

The following sections are under development:

- Source analysis.
- Total maximum daily loads and allocations which include loading capacity, linkage analysis, load allocations, margin of safety, critical conditions, and seasonal variation.
- Implementation and monitoring.

References

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