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Technical Support Document For Water Quality-based Toxics Control

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TECHNICAL SUPPORT DOCUMENT FOR WATER QUALITY-BASED TOXICS CONTROL

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2.2.2 Mixing Zones

It is not always necessary to meet all water quality criteria within the discharge pipe to protect the integrity of the waterbody as a whole. Sometimes it is appropriate to allow for ambient concentrations above the criteria in small areas near outfalls. These areas are called mixing zones. Since these areas of impact, if disproportionately large, could potentially adversely impact the productivity of the waterbody, and have unanticipated ecological consequences, they should be carefully evaluated and appropriately limited in size. As our understanding of pollutant impacts on ecological systems evolves, there may be cases identified where no mixing zone is appropriate.

To ensure mixing zones do not impair the integrity of the waterbody, it should be determined that the mixing zone will not cause lethality to passing organisms and, considering likely pathways of exposure, that there are no significant human health risks. One means to achieve these objectives is to limit the size of the area affected by the mixing zones.

For application of two-number aquatic life criteria, there may be up to two types of mixing zones (Figure 2-1). In the zone immediately surrounding the outfall, neither the acute nor the chronic criterion is met. The acute criterion is met at the edge of this zone. In the next mixing zone, the acute, but not the chronic, criterion is met. The chronic criterion is met at the edge of the second mixing zone.

In the general case, where a State has both acute and chronic aquatic life criteria, as well as human health criteria, independently established mixing zone specifications may apply to each of the three types of criteria. The acute mixing zone may be sized to prevent lethality to passing organisms, the chronic mixing zone sized to protect the ecology of the waterbody as a whole, and the health criteria mixing zone sized to prevent significant human risks. For any particular pollutant from any particular discharge, the magnitude, duration, frequency, and mixing zone associated with each of the three types of criteria will determine which one most limits the allowable discharge.

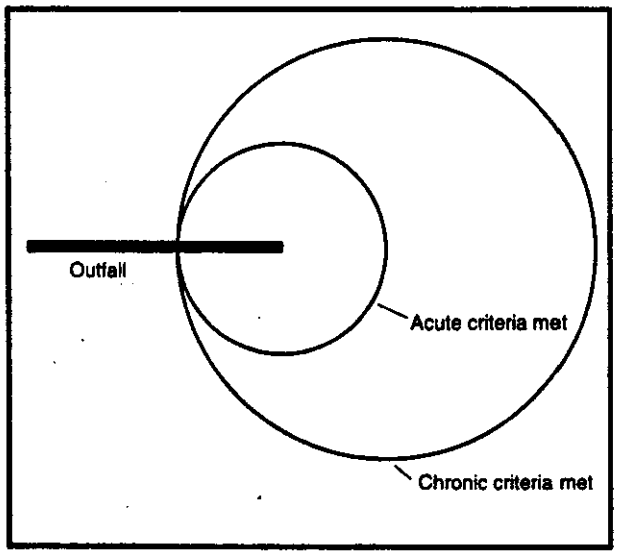

Figure 2-1. Diagram of the Two Parts of the Mixing Zone

Mixing zone allowances will increase the mass loadings of the pollutant to the waterbody, and decrease treatment requirements. They adversely impact immobile species, such as benthic communities, in the immediate vicinity of the outfall. Because of these and other factors, mixing zones must be applied carefully, so as not to impede progress toward the CWA goals of maintaining and improving water quality. EPA recommendations for allowances for mixing zones, and appropriate cautions about their use, are contained in this section.

The CWA allows mixing zones at the discretion of the State [1]. **EPA recommends that States have a definitive statement in their standards on whether or not mixing zones are allowed.** Where mixing zones provisions are part of the State standards, the State should describe the procedures for defining mixing zones.

To determine that a mixing zone is sized appropriately for aquatic life protection, water quality conditions within the mixing zone may be compared to laboratory-measured or predicted toxicity bench marks as follows:

> It is not necessary to meet chronic criteria within the mixing zone, only at the edge of the mixing zone. Conditions within the mixing zone would thus not be adequate to ensure survival, growth, and reproduction of all organisms that might otherwise attempt to reside continuously within the mixing zone.
>
> If acute criteria (CMC derived from 48- to 96-hour exposure tests) are met throughout the mixing zone, no lethality should result from temporary passage through the mixing zone. If acute criteria are exceeded no more than a few minutes in a parcel of water leaving an outfall (as assumed in deriving the Section 4.3.3 options for an outfall velocity of 3 m/sec, and a size of 50 times the discharge length scale), this likewise assures no lethality to passing organisms.
>
> If a full analysis of concentrations and hydraulic residence times within the mixing zone indicates that organisms drifting through the plume along the path of maximum exposure would not be exposed to concentrations exceeding the acute criteria when averaged over the 1-hour (or appropriate site-specific) averaging period for acute criteria, then lethality to swimming or drifting organisms ordinarily should not be expected, even for rather fast-acting toxicants. In many situations, travel time through the acute mixing zone must be less than roughly 15 minutes if a 1-hour average exposure is not to exceed the acute criterion.
>
> Where mixing zone toxicity is evaluated using the probit approach described in the water quality criteria "Bluebook" [3], or using models of toxicant accumula-

tion and action in organisms (described by Mancini [4] or Erickson et al. [5]), the phenomenon of delayed mortality should be taken into account before judging the mixing zone concentrations to be safe.

The above recommendations assume that the effluent is repulsive, such that free-swimming organisms would avoid the mixing zones. While most toxic effluents are repulsive, caution is necessary in evaluating attractive mixing zones of known effluent toxicity, and denial of such mixing zones may well be appropriate. It also is important to ensure that concentration isopleths within any plume will not extend to restrict passage of swimming organisms into tributary streams.

In all cases, the size of the mixing zone and the area within certain concentration isopleths should be evaluated for their effect on the overall biological integrity of the waterbody. If the total area affected by elevated concentrations within all mixing zones combined is small compared to the total area of a waterbody (such as a river segment), then mixing zones are likely to have little effect on the integrity of the waterbody as a whole, provided that they do not impinge on unique or critical habitats. EPA has developed a multistep procedure for evaluating the overall acceptability of mixing zones [6].

For protection of human health, the presence of mixing zones should not result in significant health risks, when evaluated using reasonable assumptions about exposure pathways. Thus, where drinking water contaminants are a concern, mixing zones should not encroach on drinking water intakes. Where fish tissue residues are a concern (either because of measured or predicted residues), mixing zones should not be projected to result in significant health risks to average consumers of fish and shellfish, after considering exposure duration of the affected aquatic organisms in the mixing zone, and the patterns of fisheries use in the area.

While fish tissue contamination tends to be a far-field problem affecting entire waterbodies rather than a narrow-scale problem confined to mixing zones, restricting or eliminating mixing zones for bioaccumulative pollutants may be appropriate under conditions such as the following:

- Mixing zones should be restricted such that they do not encroach on areas often used for fish harvesting particularly of stationary species such as shellfish.
- Mixing zones might be denied where such denial is used as a device to compensate for uncertainties in the protectiveness of the water quality criteria or uncertainties in the assimilative capacity of the waterbody.

2.3 WATER QUALITY CRITERIA FOR AQUATIC LIFE PROTECTION

2.3.1 Development Process for Criteria

The development of national numerical water quality criteria for the protection of aquatic organisms is a complex process that uses information from many areas of aquatic toxicology. (See Reference 7 for a detailed discussion of this process.) After a decision is made that a national criterion is needed for a particular material, all available information concerning toxicity to, and bioaccumulation by, aquatic organisms is collected and reviewed for acceptability. If enough acceptable data for 48- to 96-hour toxicity tests on aquatic animals are available, they are used to derive the acute criterion. If sufficient data on the ratio of acute to chronic toxicity concentrations are available, they are used to derive the chronic or long-term exposure criteria. If justified, one or both of the criteria may be related to another water quality characteristic, such as pH, temperature, or hardness. Separate criteria are developed for freshwaters and saltwaters.

The water quality standards regulation allows States to develop numerical criteria or modify EPA's recommended criteria to account for site-specific or other scientifically defensible factors. In cases where additional toxicological data are needed to modify or develop criteria, the discharger may be required to generate the data. Guidance on modifying national criteria is found in the handbook [1]. When a criterion must be developed for a chemical for which a national criterion has not been established, the regulatory authority should refer to the *Guidelines for Deriving Criteria for Aquatic Life and Human Health* (see 45 *FR* 79341, November 28, 1980, and 50 *FR* 30784, July 29, 1985).

2.3.2 Magnitude for Single Chemicals

Water quality criteria for aquatic life contain two expressions of allowable magnitude: a CMC to protect against acute (short-term) effects and a CCC to protect against chronic (long-term) effects. EPA derives acute criteria from 48- to 96-hour tests of lethality or immobilization. EPA derives chronic criteria from longer-term (often greater than 28-day) tests that measure survival, growth, reproduction, or in some cases, bioconcentration.

Most State standards include numerical criteria for a limited number of individual toxic chemicals. Therefore, evaluation and control of toxic pollutants is based on maintenance of the designated use and often relies on the narrative criterion prohibiting toxic substances in toxic amounts. The adverse effects of concern will depend on the designated use and the chemical. Bioaccumulation of chemicals in aquatic organisms, toxicity to these organisms, the potential for additivity, antagonism, synergism, and persistence of the chemicals may be important. Available information on the toxic effects of the chemical is used when standards do not include specific numerical criteria. Such information can include EPA criteria documents, published literature reports, or studies conducted by the discharger.

As mentioned in Section 2.1.2, water quality-based controls may be based directly on the State's technical determination of what concentration of a specific pollutant meets the State's narrative "free from" toxics criterion. Although EPA water quality standards regulation requires that the State's process for implementing its narrative criterion be described in the State standards, there is no requirement that this concentration be adopted as a numerical criterion in State water quality standards prior to use in developing water quality-based controls and therefore a case-by-case interpretation of the narrative criterion may be necessary.