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Water Quality Standards Handbook

Chapter 5: General Policies

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(40 CFR 131.13)

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Introduction

As specified in 40 CFR 131.13, states and authorized tribes may, at their discretion, adopt certain policies into their water quality standards (WQS) that generally affect how their WQS are applied or implemented.[1] Examples of such general policies include those affecting mixing zones, critical low flows, and WQS variances. As the regulation indicates, states and tribes are not required to adopt general policies. However, if a state or tribe chooses to adopt a general policy, such policies are subject to EPA review and approval or disapproval under Section 303(c) of the Clean Water Act (CWA) if they constitute new or revised WQS (see Chapter 1 of this Handbook). This chapter provides an overview of three types of general WQS policies. In particular, Section 5.1 of this chapter discusses mixing zones, Section 5.2 discusses critical low flows, and Section 5.3 discusses variances.

5.1 Mixing Zones

A mixing zone is a limited area or volume of water where initial dilution of a discharge takes place and where certain numeric water quality criteria may be exceeded. The CWA does not require that all criteria be met at the exact point where pollutants are discharged into a receiving water prior to the mixing of such pollutants with the receiving water. Sometimes it is possible to expose aquatic organisms to a pollutant concentration above a criterion for a short duration within a limited, clearly defined area of a waterbody while still maintaining the designated use of the waterbody as a whole. Where this is the case, a state or authorized tribe may find it appropriate to allow ambient concentrations of a pollutant above the criterion in small areas near point-source outfalls (i.e., mixing zones).

Mixing zones do not constitute new state or tribal criteria or changes to the state- or tribe-adopted and EPA-approved criteria. Therefore, the narrative and/or numeric criteria for the waterbody are still the applicable criteria within the boundaries of the mixing zone. A mixing zone simply authorizes an applicable criterion to be exceeded within a defined area of the waterbody while still protecting the designated use of the waterbody as a whole. Since 1983, the guidance in this Handbook has described mixing zones as areas where criteria may be exceeded rather than areas where criteria do not apply.

[1] Throughout this document, the term "states" means the fifty states, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands. The term "authorized tribe" or "tribe" means an Indian tribe authorized for treatment in a manner similar to a state under CWA Section 518 for purposes of Section 303(c) WQS.

By authorizing a mixing zone, states and tribes allow some portion of the waterbody to mix with and dilute particular wastewater discharges before evaluating whether the waterbody as a whole is meeting its criteria. In addition to the WQS regulation at 40 CFR 131.13 described above, the use of dilution is supported by the National Pollutant Discharge Elimination System (NPDES) permitting regulation at 40 CFR 122.44(d)(1)(ii), which requires the permitting authority to consider, where appropriate, "the dilution of the effluent in the receiving water" when determining whether a discharge causes, has the reasonable potential to cause, or contributes to an instream excursion above a criterion. Depending on the state or tribal WQS and implementation policies, a consideration of dilution could be expressed in the form of a dilution allowance or a mixing zone. A dilution allowance typically is expressed as the flow or portion of the flow of a river or stream and is typically applied in flowing waters where rapid and complete mixing occurs. A mixing zone is typically applied in any waterbody type in which incomplete mixing occurs. For more information, see Chapter 6 of the *NPDES Permit Writers' Manual* (2010).

While mixing zones serve to dilute concentrations of pollutants in effluent discharges, they also allow increases in the mass loading of the pollutant to the waterbody (more so than would occur if no mixing zone were allowed). Therefore, if not applied appropriately, a mixing zone could adversely affect mobile species passing through the mixing zone as well as less mobile species (e.g., benthic communities) in the immediate vicinity of the discharge. Because of these and other factors, mixing zones should be applied carefully so that they do not result in impairment of the designated use of the waterbody as a whole or impede progress toward the CWA goals of restoring and maintaining the physical, chemical, and biological integrity of the Nation's waters. Keeping this in mind, a state or tribe has the discretion to choose whether to authorize mixing zones and adopt a mixing zone policy. However, as described below, if a state or tribe chooses to adopt a mixing zone policy, such a policy is generally considered a new or revised WQS that must be adopted into state or tribal law and approved by the EPA before it is effective for CWA purposes.

An important note is that "mixing zone" is used in multiple ways. A *mixing zone policy* is a legally binding state or tribal policy that is adopted into WQS and describes the general characteristics of and requirements associated with mixing zones without taking into account site-specific information. The EPA generally views such mixing zone polices as constituting new or revised WQS that require EPA review and approval or disapproval under Section 303(c) of the CWA. Consistent with the four-part test described in *What is a New or Revised Water Quality Standard Under CWA Section 303(c)? Frequently Asked Questions* (2012) and Chapter 1 of this Handbook, a state or tribal mixing zone policy is a legally binding provision that is adopted into state or tribal law (part one), and it addresses the criteria component of WQS (part two). Additionally, a mixing zone policy expresses a desired condition in the waterbody to allow flexibility in meeting the applicable criteria within certain areas of the waterbody (part three), and if it is a new provision or revises an existing policy (part four), it clearly meets the requirements to be a new or revised WQS.

On the other hand, an *individual, site-specific mixing zone* is authorized for a particular point-source discharge in accordance with a state or tribal mixing zone policy and accounts for the site-specific characteristics of a particular discharge and receiving water. An individual mixing zone is defined and implemented through the NPDES permitting process. The EPA does not view individual mixing zones

as constituting new or revised WQS requiring EPA review under Section 303(c). Like a mixing zone policy, an individual mixing zone is a legally binding provision that is established pursuant to state or tribal law (part one), and it addresses the criteria component of WQS (part two). However, unlike a mixing zone policy, an individual mixing zone does not express or establish a desired condition in the waterbody (part three). Instead, the individual mixing zone is used to establish appropriate water quality-based effluent limits (WQBELs) for a specific discharger's NPDES permit. An individual mixing zone also does not establish a new provision or revise an existing provision (part four). Rather, it implements a WQS (i.e., the state or tribal mixing zone policy) for a specific discharger using site-specific information.

Additionally, any time an effluent is discharged into a receiving water, there will be a zone of *actual or physical mixing* in which the discharge and receiving water naturally mix regardless of whether a mixing zone, in the regulatory sense, has been authorized. Such actual mixing is described using field studies and a water quality model and is used in establishing an individual, site-specific mixing zone for a particular discharge.

The authorization of mixing zones under incompletely mixed discharge and receiving water situations pre-dates the CWA. The EPA's current mixing zone guidance, contained in this Handbook, the *Technical Support Document for Water Quality-based Toxics Control* (TSD) (1991), and the *NPDES Permit Writers' Manual* (2010), evolved from previous guidance from the EPA and its predecessor agencies on the use of mixing zones as a regulatory tool to address the incomplete mixing of wastewater discharges in receiving waters. This Handbook describes the EPA's recommendations for state and tribal mixing zone policies. The other two documents listed above describe the technical and permitting aspects of defining individual, site-specific mixing zones for point-source discharges during the NPDES permitting process. Additional information on mixing zones can also be found in the EPA's *Compilation of EPA Mixing Zone Documents* (2006) and *Advanced Notice of Proposed Rulemaking for Water Quality Standards* (1998).

5.1.1 Recommended Contents of State and Tribal Mixing Zone Policies

The EPA recommends that states and authorized tribes adopt, at a minimum, a definitive statement into their WQS specifying whether the state or tribe intends to authorize mixing zones. Consistent with the discussion above, where a mixing zone is authorized, water quality criteria are met at the edge of the mixing zone during critical low-flow conditions (which are described in Section 5.2 of this chapter) so that the designated use of the waterbody as a whole is protected. If a state or tribe chooses to adopt a mixing zone policy, such a policy should ensure the following:

- Mixing zones do not impair the designated use of the waterbody as a whole.
- Pollutant concentrations within the mixing zone are not lethal to organisms passing through the mixing zone.[2]

[2] Lethality is a function of the magnitude of a pollutant concentration and the duration an organism is exposed to that concentration. Section 4.3.3 of the TSD (1991) describes various

- Pollutant concentrations within the mixing zone do not cause significant human health risks considering likely pathways of exposure.
- Mixing zones do not endanger critical areas such as breeding or spawning grounds, habitat for threatened or endangered species, areas with sensitive biota, shellfish beds, fisheries, drinking water intakes and sources, or recreational areas.

Because pollutant concentrations may exceed numeric criteria within mixing zones, these elevated concentrations could adversely affect the productivity of the waterbody and have unanticipated ecological consequences. Therefore, the EPA recommends that the use of mixing zones in the development of WQBELs in NPDES permits be carefully evaluated and appropriately limited on a case-by-case basis in light of the overarching requirement to protect the designated use of the waterbody as a whole pursuant to 40 CFR 131.10.

Due to potential additive or synergistic effects of certain pollutants that could result in the designated use of the waterbody as a whole not being protected, state and tribal mixing zone policies should specify, and permitting authorities should ensure, that mixing zones do not overlap. Additionally, the EPA recommends that permitting authorities evaluate the cumulative effects of multiple mixing zones within the same waterbody. The EPA has developed a holistic approach to determine whether a mixing zone is appropriate based on such cumulative effects considering all of the impacts to the designated uses of the waterbody (see *Allocated Impact Zones for Areas of Non-Compliance* (1995)). If the total area affected by elevated concentrations within all mixing zones combined is small compared to the total area of the waterbody in which the mixing zones are located, then mixing zones are likely to have little effect on the designated use of the waterbody as a whole, provided that they do not impinge on unique or critical habitats. As understanding of pollutant impacts on ecological systems evolves, states and tribes may find specific cases in which no mixing zone is appropriate.

States and tribes that choose to adopt mixing zone policies should describe the general procedures for defining and implementing mixing zones in terms of location, maximum size, shape, outfall design, and in-zone water quality, at a minimum. Such policies should be sufficiently detailed to support regulatory actions, issuance of permits, and determination of best management practices for nonpoint sources.

The EPA recommends that specific characteristics of an individual mixing zone for a specific discharger be defined on a case-by-case basis using the state or tribal mixing zone policy. This site-specific assessment would ideally take into consideration the physical, chemical, and biological characteristics of the discharge (including the type of pollutant discharged) and receiving waterbody; the life history and behavior of organisms in the receiving waterbody; and the designated uses of the waterbody.

Location

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methods for preventing lethality to organisms passing through a mixing zone.

States and authorized tribes should restrict the potential locations of mixing zones as a way to protect stationary benthic organisms and human health from the potential adverse effects of elevated pollutant levels. In addition, states and tribes should prohibit mixing zones where they may endanger biologically important and other critical areas that the state, tribe, or federal government has identified. These include breeding and spawning grounds, habitat for threatened or endangered species, areas with sensitive biota, shellfish beds, fisheries, drinking water intakes and sources, and recreational areas.

Pollutant concentrations above the chronic aquatic life water quality criterion may prevent sensitive taxa from living and reproducing successfully within the mixing zone. In this regard, benthic and territorial organisms may be of greatest concern in protecting aquatic life within a mixing zone. The higher the pollutant concentrations occurring within the mixing zone, the more taxa are likely to be adversely affected, thereby affecting the structure and function of the ecological community and, potentially, the designated use of the waterbody as a whole.

For protection of human health, states and tribes should restrict mixing zones such that they do not result in significant human health risks when evaluated using reasonable assumptions about exposure pathways. For example, where drinking water contaminants are a concern, the mixing zones should not encroach on drinking water intakes and sources. Where fish tissue residues are a concern (either because of measured or predicted residues), mixing zones should not result in significant human health risks to average and sensitive subpopulations of 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. Where waters are designated for primary contact recreation, mixing zones for bacteria should not result in significant human health risks to people recreating in such waters. In all cases, it is critical that the designated use of the waterbody as a whole is protected.

Size

In order to protect the designated uses of the waterbody as a whole, pollutant concentrations within any mixing zone should not be lethal to mobile, migrating, and drifting organisms in the waterbody or cause significant human health risks considering likely pathways of exposure. One means of achieving these objectives is to limit the size of the mixing zone.

Most states and authorized tribes allow mixing zones as a matter of policy but also specify general spatial dimensions that limit their size. States and tribes have developed various methods of defining the maximum allowable size of mixing zones for various types of waters. State and tribal policies dealing with streams and rivers often limit mixing zone widths, cross-sectional areas, and/or flow volumes and allow lengths to be determined on a case-by-case basis. For lakes, estuaries, and coastal waters, dimensions are usually specified by surface area, width, cross-sectional area, and/or volume. The EPA recommends that states and tribes use methods that result in quantitative measures sufficient for permitting authorities to develop WQBELs in a transparent and straightforward manner.

If a mixing zone is authorized for a specific discharge, the permitting authority then defines the actual size of an individual, site-specific mixing zone for the specific discharge on a case-by-case basis using the general size restrictions in the state or tribal mixing zone policy. The area or volume of an individual mixing zone or group of mixing zones should be as small as practicable so that it does not interfere with the designated uses or with the established community of aquatic life in the segment for which the uses are designated.

In general, where a state or tribe has both acute and chronic aquatic life water quality criteria as well as human health criteria for the same pollutant, states and tribes may establish independent mixing zone size specifications that apply to each criteria type. For aquatic life criteria, there may be up to two types of mixing zones: one for the acute criterion and one for the chronic criterion (see Figure 5.1).

In the zone immediately surrounding the outfall, both the acute and the chronic criteria may be exceeded, but the acute criterion is met at the edge of this zone, which is often referred to as the acute mixing zone or the zone of initial dilution. The acute mixing zone is sized to prevent lethality to passing organisms in order to protect the designated use of the waterbody as a whole.

In the next mixing zone, which is often called the chronic mixing zone, the chronic criterion may be exceeded, but the acute criterion is met. The chronic criterion is met at the edge of the chronic mixing zone. The chronic mixing zone is sized to protect the designated use of the waterbody as a whole.

Where the state or tribe also has human health criteria for the pollutant of concern, the human health mixing zone is sized to prevent significant human risks in order to protect the designated use of the waterbody as a whole.

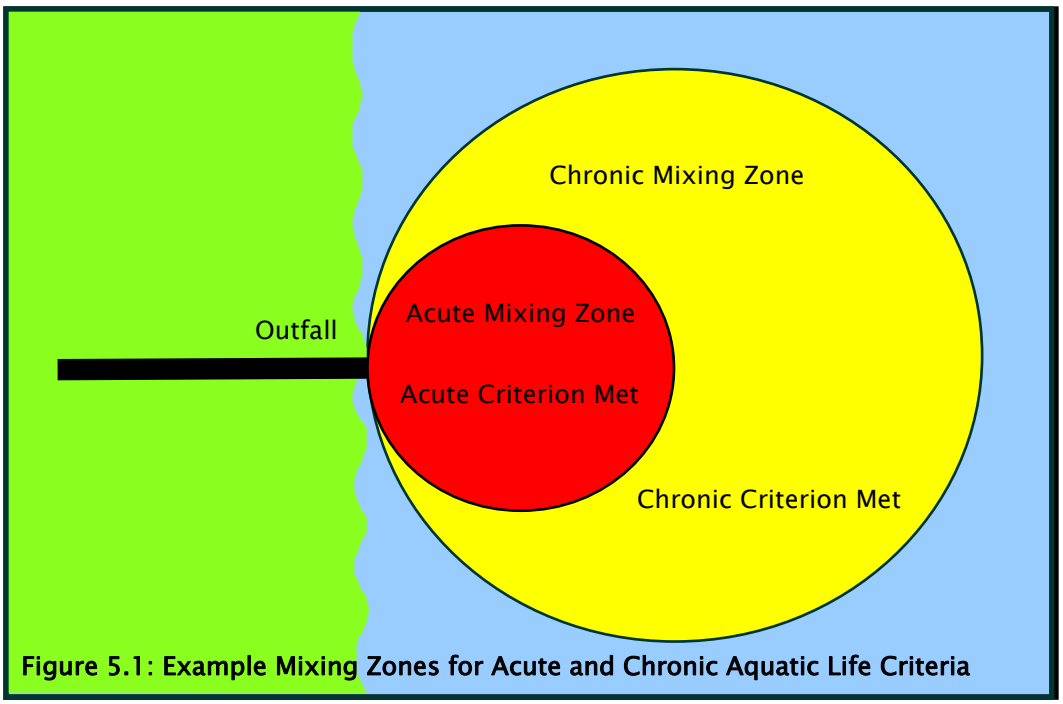

Figure 5.1: Example Mixing Zones for Acute and Chronic Aquatic Life Criteria

For a particular pollutant found in a particular discharge, the magnitude, duration, frequency, and any authorized mixing zone associated with each of the criteria types (i.e., human health and acute and chronic aquatic life) will determine which criterion most limits the allowable discharge. In all cases, the permitting authority should evaluate the size of the site-specific mixing zone to determine its effect on the designated use of the waterbody as a whole. Section 2.2.2 of the TSD (1991) contains information for determining whether a mixing zone's size is appropriate.

State and tribal mixing zone policies should identify zones of passage within waterbodies that contain migrating, free-swimming, or drifting organisms. Zones of passage are continuous water routes of such volume, area, and quality as to allow the passage of free-swimming and drifting organisms without significant adverse effects on their populations. Many species migrate for spawning and other purposes. Not only do migrating species (e.g., anadromous and catadromous species) need to be able to reach suitable spawning areas, their young (and in some cases the adults) require a safe return route to their growing and living areas. Elevated pollutant concentrations within a mixing zone can create barriers that hinder or prevent safe migration. Therefore, mixing zones should be sized and located appropriately within the waterbody to provide a continuous zone of passage that protects migrating, free-swimming, and drifting organisms.

Shape

The waterbody type, outfall design, and characteristics of the discharge will determine the shape of a mixing zone. The shape should be a simple configuration that is easy to locate in a waterbody and that avoids impingement on biologically important areas. In lakes, a circle with a specified radius is generally preferable, but other shapes may be appropriate in the case of unusual site

requirements.

"Shore-hugging" plumes should be avoided in all waterbodies. Shore areas are often the most biologically productive and sensitive areas of a waterbody, and they are often used for recreation. Shore-hugging plumes generally do not mix as well with receiving waters and, thus, do not dilute as well as mixing zones with other shapes that do not hug shorelines. Because shore-hugging plumes tend to keep unmixed water over the benthic area or in the recreational area, they are more likely to adversely affect the designated uses of the waterbody.

Outfall Design

Because outfall design affects the amount of initial mixing that occurs, state and tribal mixing zone policies should instruct dischargers to utilize the best practicable engineering design of the outfall to maximize initial mixing. Sometimes, modifying the design of the diffuser, the location of the outfall, or other outfall design characteristics can reduce significant adverse impacts to the waterbody because different design characteristics have different effects on mixing. Many different factors affect how well the outfall design allows the discharge to mix with the receiving water including the following:

- The height of the outfall with respect to the surface and bottom of the waterbody.
- The distance of the end of the pipe to the nearest bank (i.e., whether the outfall is in the middle of the waterbody or close to one side).
- The angle of the discharge.
- The type of diffuser that is used (i.e., single-port or multi-port diffuser).

Section 4.4.1 of the TSD (1991) describes recommendations for outfall design in more detail.

In-zone Water Quality

States and authorized tribes should ensure that a minimum level of water quality is maintained within a mixing zone. Mixing zones should attain the “free from” narrative water quality criteria that are applicable to all waters in a state or reservation. For example, the EPA recommends that mixing zones be free from the following:

- Materials in concentrations that will cause acutely toxic conditions to aquatic life.[3]
- Materials in concentrations that settle to form objectionable deposits.
- Floating debris, oil, scum, and other material in concentrations that form nuisances.
- Substances in concentrations that produce objectionable color, odor, taste, or turbidity.

[3] Acutely toxic conditions are those that are lethal to aquatic organisms that may pass through the mixing zone. The underlying assumption for allowing a mixing zone is that pollutant concentrations in excess of acute and chronic criteria, but below acutely toxic concentrations, may exist in small areas without causing adverse effects to the designated use of the waterbody as a whole.

- Substances in concentrations that produce undesirable aquatic life or result in a dominance of nuisance species.

5.1.2 Situations in Which Mixing Zones May Not Be Appropriate

As discussed above, states and authorized tribes are not required to allow mixing zones. Even if a state or tribe chooses to allow mixing zones generally, it may also choose to define in its policy circumstances under which mixing zones are prohibited (e.g., for particular pollutants and/or waterbodies). Likewise, where the state or tribe generally allows mixing zones, the permitting authority may decide that a mixing zone is not appropriate for a particular discharge on a site-specific basis.[4] States and tribes should conclude that mixing zones are not appropriate in the following situations:

- Where they may impair the designated use of the waterbody as a whole.
- Where they contain pollutant concentrations that may be lethal to passing organisms.
- Where they contain pollutant concentrations that may cause significant human health risks considering likely pathways of exposure.
- Where they may endanger critical areas such as breeding and spawning grounds, habitat for threatened or endangered species, areas with sensitive biota, shellfish beds, fisheries, drinking water intakes and sources, and recreational areas.

Additionally, states and tribes should carefully consider whether mixing zones are appropriate where a discharge contains bioaccumulative, pathogenic, persistent, carcinogenic, mutagenic, or teratogenic pollutants or where a discharge containing toxic pollutants may attract aquatic life.

Bioaccumlative pollutants are one example of a pollutant for which mixing zones may not be appropriate because they may cause significant human health risks such that the designated use of the waterbody as a whole may not be protected.[5] Therefore, the EPA recommends that state and tribal mixing zone policies do not allow mixing zones for discharges of bioaccumulative pollutants. The EPA adopted this approach in 2000 when it amended its 1995 *Final Water Quality Guidance for the Great Lakes System* at 40 CFR Part 132 to phase out mixing zones for existing discharges of bioaccumulative pollutants within the Great Lakes Basin and ban such mixing zones for new discharges within the Basin.

Because fish tissue contamination tends to be a far-field problem affecting entire or downstream waterbodies rather than a near-field problem being confined to the area within a mixing zone, a state or tribe may find it appropriate to restrict or eliminate mixing zones for bioaccumulative

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[4] The 1996 memorandum *EPA Guidance on Application of State Mixing Zone Policies in EPA-issued NPDES Permits* describes the circumstances under which the EPA may include a mixing zone in an NPDES permit when the EPA is the permitting authority.

[5] However, note that some chemicals of relatively low toxicity such as zinc will bioconcentrate in fish without harmful effects resulting from human consumption.

pollutants in certain situations such as the following:

- Where mixing zones may encroach on areas often used for fish harvesting, particularly for stationary species such as shellfish.
- Where there are uncertainties in the protectiveness of the water quality criteria or the assimilative capacity of the waterbody.

Chapter 3 of this Handbook and Chapter 5 of *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000) provide additional information about bioaccumulation, and Section 4.3.4 of the TSD (1991) discusses preventing bioaccumulation problems for human health in calculating WQBELs.

Another example of a pollutant for which a mixing zone may not be appropriate is bacteria. Because bacteria mixing zones may cause significant human health risks and endanger critical areas (e.g., recreational areas), the EPA recommends that state and tribal mixing zone policies do not allow mixing zones for bacteria in waters designated for primary contact recreation. The presumption in a river or stream segment designated for primary contact recreation is that primary contact recreation can safely occur throughout the segment and, therefore, that bacteria levels will not exceed criteria throughout the segment. Epidemiological studies have demonstrated that illness rates are higher when the criteria are exceeded compared to when those criteria are not exceeded (see Sections 3.2 and 3.3 of the EPA's *Recreational Water Quality Criteria* (2012)). Therefore, people recreating in or through a bacteria mixing zone (where bacteria levels may be elevated above the criteria levels) may be exposed to greater risk of gastrointestinal illness than would otherwise be allowed by the state or tribal criteria for protection of the recreation use. Given this presumption, states and tribes should carefully evaluate whether authorizing a mixing zone that results in elevated levels of bacteria in a river or stream designated for primary contact recreation will adversely affect the designated use. If so, then states and tribes should not authorize such mixing zones because they could result in a significant human health risk.

A third example of a situation in which the EPA recommends that states and tribes prohibit a mixing zone is when an effluent is known to attract biota. In such cases, a continuous zone of passage around the mixing area will not protect aquatic life. Although most toxic pollutants elicit a neutral or avoidance response, there are some situations in which aquatic life are attracted to a toxic discharge and, therefore, can potentially incur significant exposure. For example, temperature can be an attractive force and may counter an avoidance response to a particular pollutant. Therefore, the organisms would tend to stay in the mixing zone rather than passing through or around it. Innate behavior such as migration may also counter an avoidance response and cause fish to incur significant exposure.

5.1.3 Mixing Zones for the Discharge of Dredged or Fill Material

In conjunction with the Department of the Army, the EPA has developed guidelines at 40 CFR Part 230 for evaluating discharges of dredged or fill material into navigable waters, which include

provisions at 40 CFR 230.11(f) for determining the acceptability of mixing zones for such material. Discharges of dredged or fill material are generally temporary and result in short-term disruption to the waterbody rather than constituting a continuous discharge with long-term disruption beyond the fill area. In authorizing and establishing mixing zones for dredge and fill activities, the state or authorized tribe's primary consideration should be achieving and protecting the designated uses of the waterbody pursuant to 40 CFR 131.10. As such, states and tribes should evaluate the particular pollutants involved for their effects on the designated use. Technical guidance for determining the potential for contaminant-related impacts associated with the discharge of dredged material can be found in *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual: Inland Testing Manual* (1998).

5.1.4 Mixing Zones for Aquaculture Projects

Under Section 318 of the CWA, permitting authorities may allow discharges of certain pollutants associated with approved aquaculture projects. Consistent with 40 CFR 122.25, an aquaculture project is a defined, managed water area into which certain pollutants are discharged for the maintenance or production of harvestable freshwater, estuarine, or marine plants or animals. The EPA's regulations at 40 CFR 125.11 provide that aquaculture project approval must not result in the enlargement of a pre-existing mixing zone beyond the area designated for the original discharge and that the designated project area (which is also defined at 40 CFR 122.25) must not include a portion of a waterbody large enough to expose a substantial portion of the indigenous biota to the conditions within the designated project area. For example, a designated project area should not include the entire width of a stream because all of the indigenous organisms might be exposed to pollutant discharges that would exceed WQS. The areas designated for approved aquaculture projects should be treated in the same manner as other mixing zones.

5.2 Critical Low Flows for Water Quality Criteria Implementation

Pursuant to 40 CFR 131.11(a), states and authorized tribes must adopt those water quality criteria that protect designated uses. To ensure that adopted criteria are protective of the designated uses, states and tribes generally establish critical low-flow values to support implementation of the applicable criteria through such programs as NPDES permitting.

Critical low-flow conditions present special challenges to the integrity of the aquatic community and the protection of human health. Dilution is one of the primary mechanisms by which the concentrations of contaminants in effluent discharges are reduced following their introduction into a receiving water. Low flows in the receiving water typically aggravate the effects of effluent discharges because, during a low-flow event, there is less water available for dilution, resulting in higher instream concentrations of pollutants. Therefore, the allowable dilution (which may be only a portion of the critical low flow depending on the state or tribal WQS and implementation

procedures) for purposes of determining the need for and establishing WQBELs in NPDES permits should ensure protection of the applicable criteria at the calculated critical low-flow value.

The EPA has historically encouraged states and tribes to specify directly within their WQS which calculated critical low-flow values should be used to determine the available dilution for the purposes of determining the need for and establishing WQBELs. Such critical low-flow values have historically been reviewed and approved or disapproved by the EPA as new or revised WQS under Section 303(c) of the CWA. Likewise, revisions to those critical low-flow values would generally constitute new or revised WQS subject to EPA review and approval or disapproval (see Chapter 1 of this Handbook and *What is a New or Revised Water Quality Standard Under CWA Section 303(c)? Frequently Asked Questions* (2012)).

Most states and tribes generally follow the guidance in the TSD (1991) when adopting critical low-flow values for criteria implementation. The EPA recommends that states and tribes adopt the critical low-flow values for use in steady-state analyses so that criteria are implemented appropriately. If criteria are implemented using inappropriate critical low-flow values (i.e., calculated values that are too high), the resulting control of toxic pollutants may not be fully protective because the resulting ambient concentrations could exceed criteria when such low flows occur. In the case of aquatic life, more frequent excursions than are allowable (e.g., more than once in three years) could result in unacceptable effects on aquatic organisms and designated uses if the appropriate value is not used in the calculations.

In addition to steady-state models, the TSD recommends the use of three dynamic models to perform wasteload allocations. Because dynamic wasteload models do not generally use specific steady-state critical low-flow values but accomplish the same effect by factoring in the probability of occurrence of stream flows based on the historical flow record, this Handbook discusses only steady-state conditions.

In Appendix D of the TSD and *Technical Guidance Manual for Performing Wasteload Allocations, Book VI: Design Conditions – Chapter 1: Stream Design Flow for Steady-State Modeling* (1986), the EPA describes and recommends two methods for calculating acceptable critical low-flow values: the traditional hydrologically based method developed by the United States Geological Survey (USGS) and a biologically based method developed by the EPA.[6] The hydrologically based critical low-flow value is determined statistically using probability and extreme values, while the biologically based critical low flow is determined empirically using the specific duration and frequency associated with the criterion.

Additionally, the two documents listed above describe the flow values that the EPA recommends for implementing acute and chronic criteria using both methods. Table 5.1 below summarizes these recommendations.

[6] In some EPA documents such as those cited, critical low flow is also called "design flow" or "stream design flow." These terms are different from a facility or effluent design flow.

Table 5.1: EPA-recommended Critical Low Flows for Aquatic Life and Human Health Criteria

Criteria	Hydrologically Based Flow	Biologically Based Flow
Acute Aquatic Life	1Q10	1B3
Chronic Aquatic Life	7Q10	4B3
Human Health	Harmonic mean	

Using the hydrologically based method, 1Q10 represents the lowest one-day average flow event expected to occur once every ten years, on average, and 7Q10 represents the lowest seven-consecutive-day average flow event expected to occur once every ten years, on average. Using the biologically based method, 1B3 represents the lowest one-day average flow event expected to occur once every three years, on average, and 4B3 represents the lowest four-consecutive-day average flow event expected to occur once every three years, on average.

States and tribes may designate other critical low-flow values to implement the applicable criteria, provided they are scientifically justified. The EPA has also recommended critical low-flow values that differ from the above recommendations for specific pollutants such 30Q5, 30Q10, and 30B3 for implementing chronic criteria for ammonia.

The EPA does not view the fact that many streams within a state or tribe have no flow at 7Q10 as adequate justification for designating alternative flows. Note that, when a criterion specifies a four-day average concentration that should not be exceeded more than once every three years, this condition should not be interpreted as implying that a 4Q3 low flow is appropriate for use as the hydrologically based critical low-flow value for assessing impacts on the receiving water.

The EPA recommends the harmonic mean flow for implementing human health criteria. The concept of a harmonic mean is a standard statistical data analysis technique. The EPA's model for human health effects assumes that such effects occur because of a long-term exposure to low concentrations of a toxic pollutant (e.g., two liters of water per day for seventy years). The harmonic mean flow allows for estimating the concentration of toxic pollutant contained in those two liters of water per day when the daily variation in the flow rate is high. Therefore, the EPA recommends use of the harmonic mean flow in computing critical low flows for human health criteria rather than using other averaging techniques.

In addition to the documents listed above, see the EPA's *Flow 101* webpage and *Advanced Notice of Proposed Rulemaking for Water Quality Standards* (1998) for additional information on critical low flows.

The EPA notes that the USGS has documented that, in some areas of the United States, there have been changes to the critical low flows in freshwater rivers and streams or increased duration and frequency of low flow occurrence. The source of the reductions may often be anthropogenic in origin such as over-pumping of groundwater, hydrologic alteration including impoundments, or surface water withdrawals. Some of these reductions may persist long enough to cause changes to the critical low-flow values. In addition, prolonged droughts have resulted in a reduction of the low-flow minimums released on regulated rivers or revisions to drought control manuals to allow

for further reductions of the low-flow values. During prolonged droughts, there may also be a trend towards increased pumping of groundwater, which may, in turn, lead to a reduction of surface water flows. New water intakes may also permanently change a waterbody's critical low flow. The following documents provide additional information on changing flow patterns:

- The USGS's *National Water Census – Streamflow* webpage.
- The USGS's *Groundwater Depletion in the United States (1900–2008)* (2013).
- The USGS's *Alteration of Streamflow Magnitudes and Potential Ecological Consequences: a Multiregional Assessment* (2011).
- The EPA's *Report on the Environment – Fresh Surface Water* webpage.

It may be prudent for states and tribes to review and revise, as appropriate, their critical low-flow values during the triennial review process to account for changes to historical flow patterns. Also, NPDES permitting authorities should be aware that these altered historical flow patterns in rivers and streams may render historical flow records less accurate in predicting current and future critical flows. Where appropriate, permitting authorities should consider alternate approaches to establishing critical low-flow conditions that account for these climatic and anthropogenic changes when conducting reasonable potential analyses and in establishing protective WQBELs (see *NPDES Permit Writers' Manual: Inclusion of Climate Change Considerations*).

5.3 Variances from Water Quality Standards

A WQS variance is a time-limited designated use and water quality criterion for a specific pollutant(s) or water quality parameter(s) that reflect the highest attainable condition during the term of the WQS variance. A WQS variance may apply to an NPDES-permitted discharger or waterbody/waterbody segment(s). The regulation at 40 CFR 131.13 provides that states and authorized tribes may adopt into their WQS general variance policies that describe how they intend to apply and implement variances. Although such variance policies require EPA review and approval, states and tribes are not required to adopt variance policies in order to adopt individual variances. Nevertheless, as opposed to individual mixing zones (discussed in Section 5.1 of this chapter), the individual variances themselves must be adopted into WQS (or other legally binding state or tribal requirements) and approved by the EPA before they can be effective for CWA purposes.

Although the legal authority to adopt a WQS variance is the same as a revision to a designated use, the purpose of a variance is different from that of a designated use revision (described in Chapter 2 of this Handbook). A variance is intended to serve as a mechanism to provide time for states, tribes, and stakeholders to implement actions to improve water quality over an identified period of time when and where the designated use currently in place is not being met. When utilizing a variance, the state or tribe retains the designated use that is currently in place as a long-term goal. As first articulated in 1977 in *Decision of the General Counsel on Matters of Law Pursuant to 40 CFR Section 125.36(m). No. 58*, a state or tribe may adopt a WQS variance if the state or tribe can satisfy the same substantive and procedural requirements as a designated use removal, which are described in 40 CFR 131.10(g).

A variance is also different from a permit compliance schedule. While both tools can provide time to meet regulatory requirements, which tool is appropriate depends upon the circumstances. Variances can be appropriate to address situations where it is known that the designated use and criterion are unattainable today (or for a limited period of time), but feasible progress could be made toward attaining the designated use and criterion. A permit compliance schedule, on the other hand, may be appropriate when the designated use is attainable, but the discharger needs additional time to modify or upgrade treatment facilities in order to meet its WQBEL such that a schedule and resulting milestones will lead to compliance "as soon as possible" with the WQBEL based on the currently applicable WQS. See CWA Section 502(17) for a definition of "schedules of compliance" and 40 CFR 122.47.

A variance may be appropriate where a state or tribe determines that the designated use cannot be attained for a period of time because the discharger cannot immediately meet a WQBEL, which is written to meet a particular WQS, or a waterbody/waterbody segment cannot immediately meet the criteria to protect the designated use. Under such circumstances, the variance provides a targeted, time-limited revision to the WQS that reflects the highest attainable condition. These new time-limited WQS then serve as the basis for pollution control requirements during the term of the

variance. For WQS variances that apply to aquatic life, wildlife, and recreational uses (i.e., the Section 101(a)(2) uses), this means that attainment of the designated use is infeasible under at least one of the six factors at 131.10(g) for at least the term of the variance.

The practical effect of the variance is an NPDES permit containing a WQBEL that complies with a less stringent criterion than would otherwise be in effect in the absence of the variance. However, the underlying designated use and criteria remain in effect for Section 303(d) listing and total maximum daily load development regardless of whether the variance is for a single discharger, multiple dischargers, or a waterbody/waterbody segment. At the end of the variance term, the discharger's WQBEL must ensure compliance with the underlying designated use and criterion or the state or tribe must obtain a new variance. To obtain a new variance, the state or tribe must again demonstrate that the designated use is not attainable at the point of discharge and again submit the variance to the EPA for review and approval or disapproval.

In many cases, a WQS variance is an environmentally useful tool because a variance exists only for a defined term and retains designated use protection for all pollutants and sources, with the sole exception of those specified in the variance. Even the discharger with a variance for a particular pollutant is required to meet applicable criteria for all other pollutants. Thus, a variance can result in water quality improvements over time and, in some cases, full attainment of designated uses by maintaining existing water quality protections while allowing time for advances in treatment technologies, control practices, or other changes in circumstances.

States and tribes typically adopt a WQS variance for an individual discharger for a specific pollutant in a specific waterbody. However, where multiple dischargers have similar attainment challenges, a state or tribe may streamline its variance process by adopting a multiple-discharger WQS variance. Such a variance applies to several dischargers but may be supported by a single technical rationale justifying the need for the variance. The EPA has previously published information on both individual- and multiple-discharger variances at 40 CFR Part 132. For additional information on variances, also see *Discharger-Specific Variances on a Broader Scale: Developing Credible Rationales for Variances that Apply to Multiple Dischargers* (2013).