Idaho Mixing Zone Implementation Guidance

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Prepared by
Idaho Department of Environmental Quality
Water Quality Division
1410 N. Hilton
Boise, Idaho 83706

Preface

This document provides guidance on complying with the mixing zone provisions in Idaho's "Water Quality Standards" (WQS), IDAPA 58.01.02. The information set forth in this document is intended solely as guidance for use by staff of the Idaho Department of Environmental Quality (DEQ) and the regulated public. Mixing zones will be governed by existing requirements of the Clean Water Act (CWA), US Environmental Protection Agency (EPA) implementing regulations, and the WQS. This document does not substitute for those provisions, regulations, or rules. The contents of this document do not constitute a rulemaking by DEQ. Furthermore, the contents of this document do not create any rights or benefits, substantive or procedural, enforceable by law or in equity, by any person. Nothing in this document shall be construed to constitute a valid defense by regulated parties in violation of any state or federal environmental statute, regulation, or permit.

The recommendations in this guidance are not binding; DEQ may consider other approaches consistent with the CWA, EPA regulations, and the WQS. Decisions regarding compliance with the mixing zone provisions in the WQS will be made on a case-by-case basis, taking into account comments and information presented at that time by interested persons regarding the appropriateness of applying these recommendations to the particular situation. DEQ may vary from the recommended approach outlined in this document based on site-specific information and comments provided by the public and the permit or license applicant. DEQ may change this guidance in the future.

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Acronyms, Abbreviations, and Symbols

µg/L	micrograms per liter
1Q10	1-day, 10-year minimum statistical flow value
7Q10	7-day, 10-year minimum statistical flow value
BAF	bioaccumulation factor
BCF	bioconcentration factor
CCC	criterion continuous concentration
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMC	criterion maximum concentration
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
DKHW	Davis, Kannberg, and Hirst model for Windows
EFH	essential fish habitat
EPA	US Environmental Protection Agency
ESA	Endangered Species Act
ft	feet
HEC-RAS	Hydrologic Engineering Centers River Analysis System
IC	inhibition concentration
IDAPA	refers to citations of the Idaho Administrative Procedures Act
IDFG	Idaho Department of Fish and Game
L/kg	liters per kilogram
LC_{50}	lethal concentration fifty
LOEC	lowest observed effects concentration
m	meter
m/s	meters per second
mg/L	milligrams per liter
MGD	million gallons per day
mL	milliliter
MSA	Magnuson Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NOEC	no observed effects concentration
NPDES	National Pollutant Discharge Elimination System
NRFIELD	near field model
NTU	nephelometric turbidity unit
ºC	degrees Centigrade
ºF	degrees Fahrenheit
PBT	persistent, bioaccumulative, and toxic

PCB	poly-chlorinated biphenyl
PDS	Prych, Davis, and Shirazi surface discharge model
POTW	publicly owned treatment works
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RDI	river diatom index
RfD	reference dose
RPA	reasonable potential analysis
RPTE	reasonable potential to exceed
RSB	Roberts, Snyder, and Baumgartner length scale model
SDI	stream diatom index
TBEL	technology-based effluent limitation
TMDL	total maximum daily load
TSD	EPA's Technical Support Document (see references)
TU	toxic unit
TUa	toxic unit–acute
TUc	toxic unit–chronic
UDKHDEN	updated Davis, Kannberg, and Hirst density model
UM	updated merge model
UM3	three-dimensional updated merge model
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
VP	Visual Plumes
WET	whole effluent toxicity
WQBEL	water quality-based effluent limitation
WQS	water quality standards
ZID	zone of initial dilution

Executive Summary

A mixing zone is a location within a water body that receives a discharge of wastewater effluent. The effluent mixes with the receiving water in this zone and pollutants contained within the effluent become diluted. One can control the concentrations of pollutants in the discharge, as well as the structure used for discharge, such that a mixing zone has certain characteristics; this is done for the purposes of creating a regulatory mixing zone.

Pollutants entering a receiving water body dilute in various ways; the speed of dilution and hence the size of the mixing zone depends on many features, not only the pollutant concentration but the physical and chemical characteristics of a pollutant or effluent as a whole. For example, temperature (thermal loading), ammonia, dissolved oxygen, and BOD_5 behave differently than many other pollutants for which dilution is the primary mitigating factor. Mixing also depends on the discharge type, size, and location of the port producing the discharge and the receiving water morphology and hydrology. The process of modeling or visualizing how the discharge and receiving water body mix is called a mixing zone analysis.

A regulatory mixing zone is a location within a water body where certain water quality criteria are allowed to be exceeded. The boundary of the regulatory mixing zone is defined as that location where pollutant concentrations must achieve a level that meets water quality criteria. Toxic pollutants can have an acute zone in which the acute criteria (i.e., criterion maximum concentration, or CMC) may be exceeded and a chronic zone where the chronic criteria (i.e., criterion continuous concentration, or CCC) may be exceeded.

Idaho Department of Environmental Quality (DEQ) rules require regulatory mixing zones to be no larger than necessary. For flowing water bodies, the mixing zone should not exceed 25% of the low-flow volume of the receiving water for dilution and 25% of the width of the receiving water. Under some circumstances, DEQ may allow a regulatory mixing zone that is larger than these limits. For nonflowing waters, the regulatory mixing zone is not to exceed 10% of the total horizontal area of the water body for existing discharges and 5% of the area or 100 meters in length (whichever is smaller) for new discharges.

The authorization of a mixing zone for dilution of pollutants in a discharge is not guaranteed and DEQ maintains the right to determine its necessity and size. There is no mixing available in water bodies where water quality criteria exceedances exist provided, however, the Department may authorize a mixing zone when the permitted discharge is consistent with an approved TMDL allocation or other applicable plans or analyses. The process that DEQ uses to determine the size of an allowable regulatory mixing zone is outlined in this guidance. Currently, the US Environmental Protection Agency (EPA) issues National Pollutant Discharge Elimination System (NPDES) permits for discharges in Idaho. DEQ certifies that those permits meet Idaho water quality standards under section 401 of the Clean Water Act. As part of that certification, DEQ may authorize a regulatory mixing zone.

The following process will be followed when determining whether to authorize a regulatory mixing zone for pollutants in NPDES permits:

1. EPA performs a reasonable potential analysis through reasonable potential to exceed calculations using 25% of the low-flow receiving water volume for dilution (i.e., a 25% mixing zone). The low-flow statistic used varies by criterion, but for example is

usually a 1Q10 for the CMC and a 7Q10 for the CCC. EPA develops effluent limits for pollutants that have a reasonable potential to exceed water quality criteria.[1]

2. DEQ receives the draft permit and spreadsheet used by EPA to calculate limits. DEQ will work with EPA permit staff to adjust the size of the regulatory mixing zone so that it is no larger than necessary considering siting, technological, and managerial options available to the discharger.
3. Additionally, DEQ may perform a mixing zone analysis to determine the size of the plume and its effects on the receiving water body.
4. Once regulatory mixing zones are determined, DEQ requests EPA to redraft, if necessary, the permit using new mixing zone sizes for dilution and authorizes these mixing zones in the draft 401 certification of the permit.

[1] 1Q10 refers to the lowest 1-day flow with an average recurrence frequency of 10 years. 7Q10 refers to the lowest 7-day average flow with an average recurrence frequency of 10 years.

1 Introduction

This document provides guidance to Idaho Department of Environmental Quality (DEQ) staff and members of the public on implementing IDAPA 58.01.02.060, the "Mixing Zone Policy" of Idaho's water quality standards (WQS), and where necessary, designing mixing zones in compliance with Idaho's WQS. Topics addressed include the following:

- The definition and applicability of mixing zones
- Mixing zone rules and WQS applicable to mixing zones
- Approaches to determining the size, dilution, and location of a mixing zone
- Mixing zone determinations and authorizations
- Monitoring considerations

Idaho WQS may change after this guidance is finalized; therefore, dischargers, permit writers, and DEQ staff are strongly encouraged to first consult and implement the most recent US Environmental Protection Agency (EPA)-approved Idaho WQS.

The information in this document is intended to be dynamic and should be updated based on practical experience as more information and viable techniques become available. DEQ may also consider dilution predictions or modeling analyses other than those outlined in this guidance.

1.1 Mixing Zone Definition

The mixing and dilution of wastewater effluent discharged to a receiving water body is dependent on a number of factors. In most cases, pollutants originating in the discharge become less concentrated as a discharge mixes with a receiving water body, entraining more and more of the receiving water until becoming fully mixed.

Idaho WQS define a mixing zone as follows:

> A defined area or volume of the receiving water surrounding or adjacent to a wastewater discharge where the receiving water, as a result of the discharge, may not meet all applicable water quality criteria or standards. It is considered a place where wastewater mixes with receiving water and not as a place where effluents are treated. (IDAPA 58.01.02.010.61)

The term "mixing zone" is a regulatory construct—a defined boundary within a discharge plume where water quality criteria may be exceeded. Figure 1 illustrates the various sizes and configurations of a regulatory mixing zone in flowing and nonflowing waters. Acute criteria should be met at the zone of initial dilution (ZID) boundary; chronic and narrative criteria must be met at the boundary of the mixing zone (IDAPA 58.01.02.060.01.b).

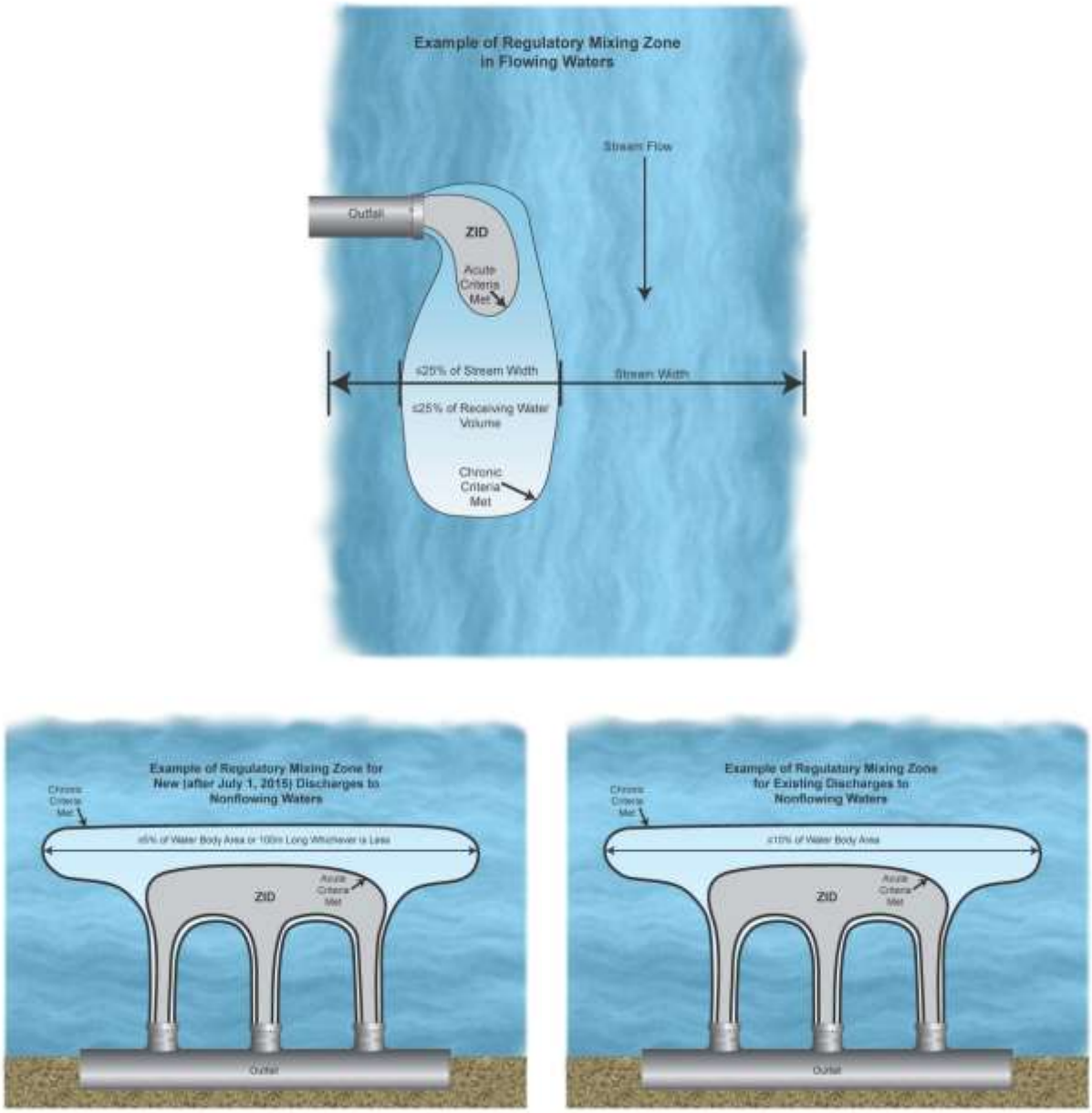

Figure 1. Examples of mixing zones in flowing (top) and nonflowing (bottom) waters. ZID indicates the zone of initial dilution.

Mixing zone analysis is not an exact science and most often relies on model results and field tracer (dye) studies to estimate the potential dilution and size of the area required for homogenous mixing. The formulas and algorithms used in mixing zone models are conservative by design, and conservative values are employed when determining model inputs. As such, the actual dilution will likely be more rapid than the calculated value. Data inputs for mixing zone analyses will vary depending on discharge and ambient conditions.

Ambient data are often limited, especially data related to hydrographic and hydrodynamic characteristics of the receiving water. More complex analysis may require collecting site-specific

data; however, it may be necessary for a modeler to use "best estimate" values where resources are limited or difficulties in collecting ambient data are encountered.

1.2 Mixing Zone Applicability

For a publicly owned treatment works (POTW) or a specific industry that discharges to waters of the US, the Clean Water Act (CWA) requires EPA to develop national effluent standards that represent minimum levels of pollutant reductions that are technologically and economically achievable for a group of facilities with similar characteristics. National effluent standards are promulgated in the Code of Federal Regulations (CFR) and based on particular model technologies; however, they do not require installation of a particular technology, only that dischargers meet a given effluent limitation. These standards are commonly referred to as technology-based effluent limits (TBELs) and must be achieved at the point of discharge. Permit writers may use their best professional judgement when establishing a TBEL for a pollutant that does not have a national effluent standard.

When drafting a National or Idaho Pollutant Discharge Elimination System (NPDES, for ease of drafting this guidance this document will use NPDES) permit, a permit writer must consider the impact of the proposed discharge on the quality of the receiving water. By analyzing the effect of a discharge on the receiving water, a permit writer could find that TBELs alone will not achieve the applicable water quality standards. Where more stringent effluent limits are necessary to protect beneficial uses in the receiving water, these limits are referred to as water quality-based effluent limits (WQBELs). Federal regulations implementing the CWA allow states to establish zones in receiving waters that may exceed numeric water quality criteria, as long as the beneficial uses of the receiving water body are protected. Therefore, NPDES permits may establish effluent limits that exceed water quality criteria within the regulatory mixing zone.

A permit writer conducts a reasonable potential analysis (RPA) to determine whether there is a reasonable potential for a discharge to cause or contribute to an exceedance of water quality criteria. Per 40 CFR 122.44(d)(1)(ii), dilution is permissible and an RPA may use dilution of the effluent to determine whether an effluent limit is required to support beneficial uses in the receiving water. EPA follows a recommended approach defined in the *Technical Support Document for Water Quality-based Toxics Control* (TSD)(EPA 1991) when conducting an RPA. This approach uses maximum projected effluent concentrations, background concentrations, and a dilution factor as determined in the RPA to project a maximum receiving water concentration at the boundary of the mixing zone.

A dilution factor represents the ratio of a proportion of the receiving water body low flow (i.e., the low-flow design discharge conditions) and the effluent discharge:

$$Dilution\ Factor = \frac{(Q_S \times P + Q_e)}{Q_e}$$

Where:

Q_s = low-flow design discharge conditions of receiving water body (in cubic feet per second)

P = mixing zone percentage (25% may be used initially to determine the level of analysis required)

Q_e = discharge flow (in cubic feet per second)

EPA may use other factors such as existing controls on point and nonpoint sources, effluent variability, or type of facility to determine whether a reasonable potential to exceed (RPTE) WQS may occur. If this concentration exceeds the most stringent applicable water quality criterion, WQBELs are required for the specific pollutant. WQBELs may be end-of-pipe limits or achieved through the use of a mixing zone.

WQBELs derived to meet aquatic life and human health water quality criteria at the mixing zone boundary, and where a mixing zone is allowed, use a dilution factor to determine end-of-pipe limits for each pollutant according to the TSD approach (see Figure 1). The TSD approach also takes into account the variability in discharge composition, the nature of the criteria, and the sampling frequency required to ensure no exceedance of water quality criteria will occur outside of the mixing zone. The TSD was written to specifically address toxic pollutants for which acute and chronic criteria were developed. Its procedures should be modified when addressing nontoxic pollutants such as phosphorus, sediment, bacteria, or temperature.

> "Whether a mixing zone is authorized, and its size, configuration and location, is determined by the Department on a case-by-case basis. This determination is made in accordance with the provisions of Section 060 at the time a permit is issued, renewed, or materially modified and is in effect as long as the permit remains in effect. Such an authorization is required before a mixing zone can be used to determine the need for, or level of, effluent limits for a particular pollutant." (IDAPA 58.01.02.060)

2 Mixing Zone Rules

Federal regulations implementing the CWA and EPA guidance largely defer to the states in establishing specific requirements of mixing zone regulations. This section summarizes Idaho's mixing zone rules. Appendix A includes each provision of IDAPA 58.01.02.060 and other mixing zone related sections of Idaho's WQS, as well as a cross-reference to where they are discussed in this guidance.

To protect beneficial uses of a receiving water body, IDAPA 58.01.02.060 requires DEQ to determine on a case-by-case basis whether a mixing zone is authorized and, if applicable, a mixing zone's size, configuration, and location.

In determining whether a mixing zone will be authorized, DEQ considers the following:

- Quality of the effluent
- The assimilative capacity of the receiving water
- Potential impacts of the mixing zone on the beneficial uses of the receiving water body

As stated previously, TBELs are the minimum level of pollutant controls for point source discharges and are based on technology and cost considerations, effluent limitation guidelines, best professional judgment, or other federal regulations and must be achieved at the end-of-pipe. Therefore, mixing zones do not apply to TBELs.

For DEQ to authorize a mixing zone, the receiving water must possess the capacity to assimilate the discharged pollutant. Assimilative capacity exists when the quality of the receiving water is better than criteria necessary to support beneficial uses. Except in certain circumstances, mixing

zones shall not be considered for any pollutant when the receiving water does not meet criteria for that pollutant.

Mixing zone evaluations should consider the discharge configuration as well as the types of pollutants being discharged and their potential effects on the chemical, biological, and physical condition of the receiving water body. Idaho's mixing zone rules stipulate that the location of a mixing zone should not cause unreasonable interference with, or danger to, beneficial uses (IDAPA 58.01.02.060.01.d).

Unreasonable interference with, or danger to, beneficial uses includes, but is not limited to, the following:

- Impairment to the integrity of the aquatic community
- Thermal shock, lethality, or loss of coldwater refugia due to heat in a discharge
- Bioaccumulation of pollutants exceeding levels protective of human health or aquatic life
- Lethality to aquatic life through passage through the mixing zone
- Exceedance of maximum contaminant levels at drinking water intakes
- Creating conditions that impede or prohibit recreation

To perform a mixing zone analysis, it is important to understand the nature and application of WQS and criteria. Section 2.1 of this guidance provides background information on WQS and criteria. Sections 2.2 and 2.3 discuss the effects of mixing zones on aquatic life and human health. Section 2.4 describes general size and location principles to consider, while section 2.5 describes submerged discharge requirements. Section 2.6 briefly addresses varied mixing zone sizes. Lastly, section 2.7 describes other considerations that may be examined during mixing zones evaluations, including points of compliance as an alternative to mixing zones.

Table 1 includes a summary of the considerations to be addressed in mixing zone evaluations.

Table 1. Summary of key considerations for mixing zone evaluations.

Key Mixing Zone Considerations	Further Information
Can water quality criteria be met at end-of-pipe?	If yes, then a mixing zone is not applicable; however, Idaho's Antidegradation Policy (IDAPA 58.01.02.051) must be considered. If not, a mixing zone analysis must be performed and a mixing zone may be authorized by DEQ.
What is the assimilative capacity of the receiving water body for the pollutants of concern in the proposed discharge?	A mixing zone is not allowed where no assimilative capacity exists (with certain exceptions per IDAPA 58.01.02.060.01.a.). The mixing zone authorization must be consistent with Idaho's Antidegradation Policy.
What is the aquatic life beneficial use(s) of the water body?	Describe the aquatic life use(s) and list the appropriate aquatic life numeric criteria for all constituents in the effluent for which a mixing zone is proposed. If an aquatic life use is not designated, DEQ generally protects the water body for cold water aquatic life.
Is salmonid spawning a beneficial use within the proposed mixing zone area?	If yes, evaluate the potential of the proposed mixing zone to adversely impact salmonid spawning; mixing zone may need to be relocated.
Does effluent contain substances known to be toxic to aquatic life?	If yes, describe all potential toxic substances, predicted concentrations within the mixing zone, and the sensitivity of the aquatic community to the toxins in the vicinity of the mixing zone (especially species and/or life stages of special concern).
Are acute water quality criteria predicted to be exceeded in the mixing zone?	If yes, describe the spatial extent of such exceedances and evaluate the potential for acutely toxic conditions.
Will the mixing zone contain any constituents known to elicit an avoidance behavior?	If yes, list these constituents and the species that will potentially be affected. Describe the spatial and temporal extent of the mixing zone and extent of the zone of passage. If no, provide a basis for this conclusion.
Will the mixing zone contain any constituents known to attract aquatic life?	If yes, list these constituents and the species that will potentially be affected. Describe the spatial and temporal extent of the mixing zone. If no, provide a basis for this conclusion.
Will the effluent include pollutants known or predicted to bioaccumulate or bioconcentrate? Are fish likely to be harvested from the water body in the vicinity of the mixing zone area?	If yes, list these pollutants and describe their predicted concentration in the mixing zone and the potential impact on the food web. In addition, discuss the assimilative capacity of the receiving system and all proposed monitoring efforts for assessing the impacts of such pollutants.
What is the contact recreation beneficial use of the water body?	Describe the public access to the mixing zone area and the seasonality of public use. Also list the human health-based numeric criteria for consumption of organisms for all constituents in the effluent for which a mixing zone is proposed. Note: where contact recreation is not designated, DEQ presumes the water body will support either primary or secondary contact recreation.

Key Mixing Zone Considerations	Further Information
Is the water body designated as a domestic water supply?	If yes, list the human health-based numeric criteria for consumption of water and organisms for all constituents in the effluent for which a mixing zone is proposed.
What is the extent of the mixing zone?	Describe the proposed mixing zone's spatial and temporal characteristics.
For existing dischargers, is there an established or proposed monitoring plan that will adequately characterize the physical, chemical, and biological conditions of the water body upstream and downstream from the proposed mixing zone?	If yes, describe the monitoring plan in detail, including all spatial and temporal aspects of the monitoring and quality assurance/quality control (QA/QC) procedures. If no, sufficient information should be submitted that describes why monitoring is not needed.
For new dischargers, is there a proposed monitoring plan that will adequately characterize the pre-discharge physical, chemical, and biological condition of the water body and all post-discharge impacts from the proposed mixing zone?	

2.1 Water Quality Standards

Section 101(a) of the CWA states that wherever attainable, waters must achieve a level of quality that provides for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water (commonly referred to as "fishable/swimmable" goals).

To achieve these goals, Idaho has adopted WQS to restore and maintain the chemical, physical, and biological integrity of waters of the US. Idaho's WQS define the water quality goals of a water body by designating the beneficial use or uses of the water body (e.g., cold water aquatic life and contact recreation), setting criteria necessary to protect those uses, and ensuring antidegradation of water quality. Idaho's beneficial use designations are listed in IDAPA 58.01.02.100. Some water bodies do not yet have designated uses. In these instances, Idaho presumes most waters will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101). Idaho also has narrative and numeric criteria in sections 200–253 of the WQS (IDAPA 58.01.02). Narrative criteria apply to all water bodies, regardless of their beneficial use. Numeric criteria are use-specific and are developed to protect either aquatic life or human health.

2.1.1 Narrative Criteria

There are eight narrative criteria (also known as "General Surface Water Quality Criteria") in Idaho's WQS (IDAPA 58.01.02.200). Narrative criteria in Subsections 200.03 and 200.05 apply within the mixing zone. Specifically, surface waters of the state shall be free from deleterious

materials and not impair designated uses; floating, suspended or submerged matter (not including suspended sediment resulting from nonpoint source activities) shall not impair designated beneficial uses in concentrations causing nuisance or objectionable conditions.

Water quality must meet WQS, including the narrative criteria, at the edge of the mixing zone. However, when natural background conditions exceed any water quality criteria (other than temperature, IDAPA 58.01.02.401.01.c), no lowering of water quality from natural background conditions is allowed.

Mixing zones must ensure the receiving water is free from the following in concentrations or quantities that impair beneficial uses of a water body:

- Hazardous materials
- Toxic substances
- Deleterious materials
- Radioactive materials (in concentrations that exceed the values listed in 10 CFR 20, Appendix B, Table 2)
- Floating, suspended, or submerged matter
- Excess nutrients
- Oxygen-demanding materials
- Sediment

Mixing zones may be authorized for numeric interpretations of narrative criteria where assimilative capacity is available and no unreasonable interference with, or danger to, beneficial uses of the water body occurs.

2.1.2 Numeric Criteria

Numeric criteria are specific to beneficial uses of a receiving water body and are used to appropriately evaluate a mixing zone. The most stringent of all applicable use-specific criteria will drive the mixing zone analysis. Idaho has numeric criteria for a variety of pollutants: toxics (see section 2.2.1), temperature, dissolved oxygen, pH, and *E. coli*. Numeric water quality criteria are listed in IDAPA 58.01.02.210–252. Additionally, IDAPA 58.01.02.401.01–03 mandates numeric criteria for temperature, turbidity, and total chlorine residual that apply to point source discharges at the edge of the mixing zone unless they are superseded by other more stringent criteria (e.g., in IDAPA 58.01.02.250).

Idaho WQS contain two types of numeric aquatic life water quality criteria for the allowable magnitude of toxic substances: acute criteria to protect against acute or lethal effects and chronic criteria to protect against long-term effects such as growth and reproduction. For individual chemicals, acute criteria were derived from

> Zone of initial dilution (ZID) is “an area within a Department authorized mixing zone where acute criteria may be exceeded. This area shall be no larger than necessary and shall be sized to prevent lethality to swimming or drifting organisms by ensuring that organisms are not exposed to concentrations exceeding acute criteria for more than one (1) hour more than once in three (3) years. The actual size of the ZID will be determined by the Department for a discharge on a case-by-case basis, taking into consideration mixing zone modeling and associated size recommendations and any other pertinent chemical, physical, and biological data available” (IDAPA 58.01.02.010.117).

48- to 96-hour tests of lethality or immobilization. Chronic criteria were derived from long-term (often greater than 28-day) tests that generally measure effects on growth and reproduction (e.g., birth defects, abnormalities, disease susceptibility and more and more behavioral effects such as avoidance, predator recognition, swimming ability, etc.), and in some cases, bioaccumulation or bioconcentration. Acute criteria should be met at the boundary of an area within the mixing zone known as the zone of initial dilution (ZID); chronic and narrative criteria must be met at the boundary of the mixing zone (IDAPA 58.01.02.060.01.b) (Figure 1).

Human health toxics criteria are based on either carcinogenic or noncarcinogenic effects. For carcinogens, an acceptable risk is based on a lifetime incremental increase in cancer risk level of 1 in 100,000 for exposed individuals (carcinogenicity of 10^{-5} risk).

For noncarcinogens, an acceptable risk is based on the reference dose (RfD). The RfD is an estimate of the daily exposure to the human population that is likely to be without appreciable risk of causing deleterious effects during a lifetime. The cancer slope factor (CSF, a measure of potency) and RfD are generally obtained from EPA's Integrated Risk Information System, but other DEQ-approved toxicological data sources may be used.

Not all toxic substances have acute, chronic, and human health criteria. Furthermore, many toxic substances do not have numeric criteria. This void is filled by the narrative toxic substances criterion (see section 2.1.1).

2.2 Effects on Aquatic Life

Mixing zones have the potential to unreasonably interfere with aquatic life (e.g., fish, benthic macroinvertebrates, and diatoms) by impairing the integrity of the aquatic community, including spawning, egg incubation, rearing, or passage; adding heat that causes thermal shock, lethality, or loss of cold water refugia; bioaccumulation of pollutants; and, lethality to aquatic life passing through the mixing zone (IDAPA 58.01.02.60.01.d). As a result, mixing zones are authorized based on a case-by-case analysis to ensure sufficient stream area and volume for protecting aquatic life beneficial uses.

Evaluation of an existing or proposed mixing zone must consider the following:

- Composition of the aquatic community, including any ecologically or economically important species
- Seasonal dynamics of the water body (both physical dynamics such as snowmelt runoff and ecological dynamics such as migrating fish)
- Physical impacts the discharge may cause
- Concentrations and nature of pollutants that may interfere with the beneficial aquatic life uses of that water body

In general, the risk of any mixing zone to aquatic life increases with the magnitude, duration, and frequency of pollutant exposure and the extent of the mixing zone. Therefore, it is critical to determine the concentration of a pollutant in the mixing zone and all expected physical and chemical habitat changes that would be associated with it. It is also important to evaluate how frequently and how long the aquatic community will be exposed to the discharge.

The biological community should be characterized before a mixing zone is authorized. Mixing zone requests for discharges to receiving waters that support sensitive species near the discharge will be reviewed with a higher degree of scrutiny. Similarly, the seasonal sensitivity of an aquatic community (e.g., during spawning runs or when vulnerable life stages are present) should also be evaluated regarding the potential impacts from the discharge on spawning.

Information regarding the aquatic communities expected to be present in Idaho waters is available in the Idaho Department of Fish and Game's (IDFG's) *Fisheries Management Plan* (IDFG 2013) and *Idaho Comprehensive Wildlife Conservation Strategy* (IDFG 2005). These plans, as well as lists of species of special concern (e.g., Bull Trout, Snake River physa) and critical habitat designations (see section 2.2.6), should be consulted early in the mixing zone evaluation process.

Critical habitat is identified for salmon and steelhead in the Federal Register (2005, see reference list). Bull Trout recovery plans, critical habitat, and other information are available from the US Fish and Wildlife Service (USFWS). Coordination with USFWS (for threatened species such as Bull Trout) and the National Marine Fisheries Service (NMFS) (for anadromous fish such as Chinook Salmon) may be advisable when species of special concern may occur in the area of the proposed mixing zone. Additional information on the location of these species' critical habitat can be found on EPA, USFWS, and NMFS websites (e.g. *http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm*). DEQ will also coordinate with the Idaho Office of Species Conservation when appropriate and refer to Idaho's Bull Trout Conservation Plan (Batt 1996).

The beneficial use of a water body (e.g., cold water aquatic life) may be a significant factor in determining the type of biological community present (including any species of concern) and whether a mixing zone is appropriate. While state water quality criteria for toxics do not vary for the aquatic life beneficial use, dissolved oxygen, temperature, and ammonia numeric criteria do. Thus, beneficial uses of a water body play an important role when evaluating and establishing such criteria in a mixing zone.

While protecting beneficial uses is the imperative, aquatic life protection includes paying attention to individual species that make up an aquatic community. The loss of individual species may in certain circumstances have a significant impact on the aquatic community as a whole. This may be the case with respect to particular species in the community that are of ecological or economic importance, as well as species more sensitive to added impact due to depressed populations.

2.2.1 Toxicity to Aquatic Organisms

Idaho water quality standards include narrative water quality criteria (IDAPA 58.01.02.60.01.d) and numeric water quality criteria (IDAPA 58.01.02.210) that address the effects of toxic pollutants on aquatic life. Further toxicity data can be found in EPA's ECOTOX databases. Using these resources and information provided by the discharger, it must be determined that acutely toxic conditions will not occur outside the ZID and that chronic water quality criteria will be met at the boundary of the proposed mixing zone (Figure 1).

Acutely toxic conditions are those conditions that cause lethality after short-term exposure (e.g., 1 hour or less). These conditions can be avoided by limiting the magnitude of pollutant concentrations as well as ensuring the frequency and duration of exposure to elevated concentrations is limited. Acute lethality is generally not expected when an organism drifting through the mixing zone along the path of maximum exposure would not be exposed to concentrations exceeding the acute criteria when averaged over a one-hour period. It can also be assumed that no lethality to passing organisms will occur in the following four scenarios (EPA 1991):

1. The acute criteria are met at end-of-pipe
2. The discharge is of high velocity ($\geq$3 meters/second) and the ZID is less than 50 times the discharge length scale in any direction
3. The discharge is of low velocity (<3 meters/second) and the most restrictive of the following conditions is met:
    a. The acute criterion will be met within 10% of the distance from the edge of the outfall to the boundary of the mixing zone (when the acute-to-chronic ratio is equal to 10 or more) in any spatial direction
    b. The ZID will be less than 50 times the discharge length scale in any spatial direction (this requirement must be met for each port in a multiport diffuser)
    c. The acute criterion will be met within a distance of 5 times the local water depth in any horizontal direction from the outfall
4. A drifting organism, when traveling through the path of maximum exposure, would pass through the acute mixing zone within 15 minutes.

2.2.2 Whole Effluent Toxicity

> The **discharge length scale** is the square root of the cross-sectional areas of the discharge pipe (or port) at its outlet.

In addition to evaluating individual toxic constituents, it may be appropriate to examine the aggregate toxicity of an effluent. However, because of the complexity of effluents, measuring aggregate toxicity through whole effluent toxicity (WET) tests may be appropriate. WET tests account for the toxicity of unknown constituents as well as synergistic or antagonistic effects among the constituents. These laboratory tests involve exposing representative aquatic organisms to various dilutions of effluent under specific conditions. The response of these organisms is used to quantify the toxicity of the aggregate effluent. Various responses, or endpoints, can be used to quantify toxicity. For example, the lethal concentration in which 50% of the test organisms die (known as lethal concentration 50, or LC_{50}) is a commonly used endpoint for acute toxicity. Commonly used endpoints for chronic toxicity tests include the no observed effects concentration (NOEC), the lowest observed effects concentration (LOEC), and the inhibition concentration (IC).

Idaho does not have numeric criteria for WET. Rather, WET tests are used to determine compliance with the narrative criteria for hazardous and toxic substances (IDAPA 58.01.02.200.01 and 200.02, respectively). If it is necessary to include WET effluent limitations or monitoring requirements in a permit, WET will be quantified using toxic units. A toxic unit (TU) is the reciprocal of the percentage of effluent that causes a specific measured acute or

chronic endpoint. Acute toxic units (TU_a) and chronic toxic units (TU_c) can be calculated as follows:

$$TU_a = 100/LC_{50}$$

$$TU_c = 100/NOEC,\ 100/IC_{25},\ \text{or}\ 100/LOEC$$

Typically, Idaho's narrative criterion for toxics is interpreted to mean $TU_a = 0.3$ and $TU_c = 1$, where LC_{50} is expressed as a percentage of effluent used in the WET test. For example, in the case of acute testing, if a solution using 50% of the effluent causes half (or 50%) of the tested organisms to die (LC_{50}) then $TU_a = 2$ (100/50). The numeric interpretations are used in the RPA and in developing WQBELs when necessary.

Mixing zones can be authorized for both acute and chronic WET effluent limitations. When authorized, the acute and chronic WET limits should be based on the instream concentration of effluent at the boundary of the ZID (acute) or boundary of the mixing zone (chronic). It is preferable that acute WET limits (e.g., no significant difference between the control and 100% effluent using hypothesis testing) be met at the end of the discharge pipe; however, DEQ may allow numeric interpretations of narrative toxics criterion for WET to be met at the edge of the ZID, as long as lethality does not occur to organisms passing through the ZID.

The most recent EPA WET guidance (EPA 2002a, 2002b) should be followed for all WET testing.

2.2.3 Zone of Passage

The extent of the mixing zone may be restricted to ensure sufficient stream area and volume for a zone of passage for aquatic life. Many salmonids migrate downstream as juveniles then upstream to spawn as adults; therefore, adequate zones of passage are necessary to maintain the biological integrity of the water body. Any authorized mixing zone for waters with established aquatic life beneficial uses must provide an adequate zone of passage to satisfy the requirement that the mixing zone not unreasonably interfere with, or endanger, established beneficial uses.

Of primary concern in evaluating the zone of passage are concentrations of various pollutants known to elicit an avoidance behavior and the location of the mixing zone relative to suitable stream velocities and depths for aquatic life passage. Since aquatic life have been shown to have their upstream passage blocked when encountering elevated concentrations of pollutants, any permitted mixing zone must provide a sufficient zone of passage such that the allowable mixing zone does not unreasonably interfere or endanger movement of aquatic life.

A comprehensive review of the scientific literature on fish avoidance was conducted by DEQ (2000). This review included fish avoidance thresholds for cadmium, copper, chromium, nickel, lead, mercury, and zinc (Table 2). Newer literature suggests that many of the threshold concentrations listed in Table 2 are still accurate, with a few exceptions. Copper toxicity and avoidance response may occur at lower concentrations than the listed 3 micrograms per liter (µg/L); avoidance has been observed at concentrations approaching 1 µg/L. Sublethal effects of copper can be less in waters with greater concentrations of dissolved organic carbon; pH may also influence copper toxicity. Literature published since 2000 includes observations of avoidance response of cadmium at levels lower than 8 µg/L; avoidance has been observed at

concentrations as low as 0.5 µg/L. Alternative avoidance threshold values, supported by adequate and appropriate scientific literature or based upon site-specific information, may be presented by the permit applicant.

Table 2. Threshold concentrations observed to elicit avoidance responses in salmonids (DEQ 2000).

Selected Avoidance Thresholds	Cadmium	Copper	Chromium	Nickel	Lead	Mercury	Zinc
	(micrograms per liter)						
Lab	8	3	10	24	14	0.2	14
Field	***16***	***3***	***20***	***48***	***28***	***0.4***	***28***

Note: Except for copper, lab avoidance thresholds from the studies reviewed were calculated by multiplying the lowest lab-to-field response ratio by two in order to obtain field avoidance thresholds. Because of ambiguity with the threshold avoidance response of juvenile Chinook Salmon to copper, the recommended avoidance threshold is 3 µg/L, without multiplication by the lab-to-field response ratio.

From a physical perspective, the mixing zone size limitations as described in section 2.4 have historically been presumed to provide an adequate zone of passage. However, to ensure that the mixing zone "shall not cause unreasonable interference with, or danger to, existing beneficial uses" (IDAPA 58.01.02.060.01.d), site-specific considerations of both channel morphology and species of particular concern should be considered, especially for discharges with small dilution factors. Channel morphology could be evaluated in conjunction with modeling efforts, as these efforts may involve detailed description of the receiving water.

Of particular concern are instances in which a mixing zone is proposed for stream channels that contain a limited percentage of stream width with characteristics (e.g., depth or flow volume) capable of supporting aquatic life passage. For example, it is not unusual for limited areas of some streams to contain areas with a well-defined thalweg adjacent to a comparatively large gravel bar over which only shallow, diffuse flow travels. In such situations, a mixing zone could occupy less than 25% of the stream width, or even less than 25% of the streamflow, but close to 100% of the useable area of the stream for fish passage. In such cases, a site-specific determination of the appropriate physical extent of a mixing zone must be made. As indicated, such considerations must take into account requirements of species of concern (e.g., migrating Chinook Salmon or sessile aquatic invertebrates). In 2014, the National Marine Fisheries Service issued a toxics substances biological opinion that provides significant guidance regarding salmonids and zone of passage considerations (specifically, Appendix F: Salmonid Zone of Passage Considerations). This publication can be accessed through DEQ's website on toxics substances criteria: *http://www.deq.idaho.gov/water-quality/surface-water/water-quality-criteria/toxic-substances-criteria/* .

2.2.4 Attraction

Discharges that attract free-swimming organisms have the potential to adversely affect aquatic life because free-swimming organisms may remain within the mixing zone area for longer periods of time extending the organisms' exposure to pollutants. DEQ may consider restricting or denying mixing zones for discharges that attract free-swimming organisms. According to the *Water Quality Standards Handbook* (EPA 2014), most toxicants elicit a neutral or avoidance response; there are some situations in which aquatic life are attracted to a toxic discharge (ref.,

http://www2.epa.gov/wqs-tech/water-quality-standards-handbook-chapters). For example, the temperature of or organic matter (as a food source) in a toxic effluent may be an attractive force to aquatic organisms. Innate behavior such as migration may also counter an avoidance response; in this instance, passage of aquatic life should be evaluated. Review of scientific literature (e.g., EPA's 1991 TSD) or other peer-reviewed documentation may be necessary where attraction is a concern.

2.2.5 Spawning

Of particular concern in Idaho is protecting the spawning activities of salmonids (trout and salmon). *Oncorhynchus* spp. spawn by depositing eggs and sperm in a depression (known as a redd) cut into the stream bottom of shallow, silt-free riffle/run habitats from large rivers to headwater streams. In general, salmon and trout typically choose to spawn in streams that are shallow, clear, and cold with a strong upwelling of water through the gravel. Discharges containing elevated suspended solids, for example, may clog these critical gravel beds. Sockeye Salmon spawning occurs almost exclusively in lakes or streams that connect to lakes. The female Sockeye most often selects a redd site in an area of the stream with fine gravels. Detailed descriptions of Chinook Salmon, steelhead, and Bull Trout spawning preferences and habitat needs by life stage are described within documents and links available from the Salmon Recovery Federal Caucus (*http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead.html*). Information on Sockeye Salmon habitat requirements can be obtained from the IDFG (*http://fishandgame.idaho.gov/public/fish/?getPage=36*). Any discharge that significantly alters habitat, lowers dissolved oxygen, or increases the temperature of a water body has the potential to impact spawning activities.

To adequately protect vulnerable fish communities, mixing zones may be prohibited during certain times of the year or within areas of the receiving water body that provide spawning and rearing habitat. The spawning periods for salmonids occur in seasonal blocks. During late winter and spring, Cutthroat Trout, Rainbow Trout, and steelhead move into spawning habitats. Anadromous and landlocked salmon (Coho, Chinook, Sockeye, and Kokanee) spawn during late summer and fall. Brown Trout, Brook Trout, and Bull Trout will typically spawn in the fall and early winter. For a mixing zone to be allowed in any spawning area, the applicant must demonstrate that the discharge will not unreasonably interfere with the capability of the receiving water body to support ongoing and future spawning, incubation, and rearing activities. Whether or not the mixing zone is to be authorized during fish spawning seasons should be carefully evaluated. Specifically, discharges with a thermal mixing zone should not cause unreasonable interference, or danger to, the impairment of the integrity of the aquatic community (e.g., impairing cold water refugia by overlapping the confluence of a smaller stream).

When a discharge is located near spawning areas, the applicant for a mixing zone should provide documentation that the pollutants discharged do not have the potential to unreasonably interfere with present or future salmonid spawning, incubation, or rearing activities in the water body. Further discussions with NMFS, USFWS, and IDFG may be necessary to determine potential impacts on spawning areas of sensitive species.

2.2.6 Species of Special Concern

Of particular concern in evaluating potential and existing mixing zones are a small group of aquatic species designated by the state as "species of special concern" because of their limited range in Idaho, low or declining populations, or threats to their existence. These species of special concern for Idaho's fisheries are of particular ecological, social, and economic importance and include Cutthroat Trout, Bull Trout, steelhead, Coho Salmon, Chinook Salmon, Kokanee Salmon, Sockeye Salmon, and White Sturgeon (all native fish). Other aquatic organisms of concern include several species of snails found in tributaries and the main stem of the Snake River: Snake River physa, Banbury Springs lanx, Bruneau hot springsnail, and the Bliss Rapids snail.

A mixing zone will not be granted if the mixing zone causes an impairment to the integrity of the aquatic community. When there are species of special concern, the impact of a mixing zone to the integrity of the aquatic community may be significant due to, for example, the depressed population of a species. Mixing zone evaluations, therefore, should include an analysis of the potential for impacts to habitat used for spawning by endangered or threatened species or species of special concern. To be adequately protective of vulnerable aquatic communities, mixing zones for Idaho's streams and rivers may not be allowed within all areas during any time of the year that the area provides critical habitat for any life stage of Sockeye Salmon, Coho Salmon, Chinook Salmon, steelhead, Kootenai River population of White Sturgeon, or Bull Trout. Furthermore, mixing zones may be very limited or prohibited within the habitat of Idaho's special status snails.

For more information on bioaccumulation:
List of Bioaccumulative Pollutants (DEQ)
www.deq.idaho.gov/media/60160659/bioaccumulative-pollutants.pdf
Bioaccumulative Properties (USGS)
http://toxics.usgs.gov/definitions/bioaccumulation
EPA PBT Chemical Program
www.epa.gov/pbt
Great Lakes Initiative
www.epa.gov/waterscience/gli/mixingzones

2.2.7 Bioaccumulation

Bioaccumulation is the elevation in concentration of substances in an organism relative to the concentration in the environment (e.g., food, water, sediment). The process involves uptake of the substance and an inability to break it down or excrete it, which leads to the organism having a higher internal concentration of the substance than its surrounding environment. Though similar to bioaccumulation, bioconcentration involves uptake from water only. In general, substances that are more lipid soluble and less water soluble are more likely to bioaccumulate. A general discussion of these properties is available through the US Geological Survey (USGS) Toxic Substances Hydrology Program website: *http://toxics.usgs.gov*. More information on and examples of bioaccumulatives can be found at the EPA Persistent, Bioaccumulative, and Toxic (PBT) Chemical Program website: *www.epa.gov/pbt* (EPA no longer updates the information, but it may be useful as a reference or resource).

The Idaho WQS specifically state that mixing zones shall not cause unreasonable interference, or danger to, beneficial uses. The bioaccumulation of pollutants (as defined in Section 010 of the WQS) resulting in tissue levels in aquatic organisms that exceed levels protective of human

health or aquatic life would constitute such interference or danger. Thus, DEQ will closely evaluate mixing zones for pollutants with a high potential to bioaccumulate to ensure such mixing zones will not lead to harmful tissue concentrations in fish, benthic macroinvertebrates, or other organisms. Examples of pollutants with a moderate to high potential to bioaccumulate that are currently present in some discharges throughout Idaho include selenium, arsenic, PCBs, and methylmercury.

Bioaccumulation intensity varies with site-specific conditions; therefore, a discharger requesting a mixing zone for bioaccumulative pollutants may be required to provide information (e.g., expected fate and transport of the substance) regarding the potential for such substances to bioaccumulate or bioconcentrate in organisms residing in the receiving water body. In addition, the discharger may be required to conduct upstream and downstream monitoring of the tissue, sediment, and/or water column concentrations for the bioaccumulative substance before (where possible) and after establishment of the discharge. This monitoring will provide insight into the potential impacts of the discharge on species present in the receiving water body and may be included as a requirement in the NPDES permit or 401 certification.

Within Idaho's mixing zone rule, mixing zones are prohibited from causing bioaccumulation of pollutants that results "in tissue levels in aquatic organisms that exceed levels protective of human health or aquatic life" (IDAPA 58.01.02.060.01.d.iii). Of the 121 toxic substances included in Idaho water quality standards (96 of which have criteria), 36 are currently defined as bioaccumulative. Substances are considered bioaccumulative, if they have a bioaccumulation factor (BAF) or bioconcentration factor (BCF) exceeding 1000 liters per kilogram (L/kg)[2].This value is a threshold for high risk of harm through bioaccumulation.

2.3 Effects on Human Health

In determining whether to allow a mixing zone or the best manner in which to monitor a mixing zone, the impacts of that mixing zone on human health must be considered. Specifically, mixing zones are not to cause unreasonable interference with beneficial uses including: bioaccumulation of pollutants (as defined in Section 010 of the WQS) resulting in tissue levels in aquatic organisms that exceed levels protective of human health or aquatic life; concentrations of pollutants that exceed Maximum Contaminant Levels at drinking water intake structures; and, conditions which impede or prohibit recreation in or on the water body (IDAPA 58.01.02.60.01.d). Potential impacts can be evaluated through water quality criteria associated with ingestion of water (domestic water supply uses) and consumption of fish (recreational uses). In determining whether human health-based criteria should be considered, the beneficial uses of the water body in question must be known. Sections 100 through 160 of the Idaho WQS identify the designated beneficial uses of Idaho's water bodies.

2 The 1000 L/kg threshold is used by EPA in determining if a chemical is bioaccumulative under the Emergency Planning and Community Right-to-Know Act of 1986. The value 1000 L/kg is based on a combination of science and policy and does not imply that chemicals with lower BAF values do not bioaccumulate or are incapable of causing harm to beneficial uses.

The following three subsections address water quality criteria developed to protect domestic water supply, contact recreation, and fish consumption.

2.3.1 Domestic Water Supply

Those water bodies designated for domestic water supply (in IDAPA 58.01.02.100.03.a) should have water quality appropriate for use as drinking water. Thus, any mixing zone must not interfere with this beneficial use.

Water quality criteria designed to protect human health can be more restrictive (i.e., allowable concentrations are lower) than corresponding water quality criteria designed to protect aquatic life. An example of this is arsenic, for which the current human health-based criterion is 0.02 µg/L to protect consumption of water and organisms and 6.2 ug/L to protect consumption of organisms only, while aquatic life-based criteria are 150 µg/L (chronic concentration) and 340 µg/L (acute concentration). Another example is the organochlorine pesticide Aldrin, for which the human health-based criterion is 0.0000025 µg/L, while the aquatic life-based criterion maximum concentration (CMC) is 3 µg/L. More information regarding applicable human health-based (and aquatic life-based) water quality criteria is given in IDAPA 58.01.02.210.

When evaluating any proposed mixing zone, its proximity to existing and/or proposed domestic water intakes will be considered. DEQ will not authorize a mixing zone that will cause concentrations above a drinking water maximum contaminant level at a surface water supply intake. Dilution models should be used to determine the potential proximity of the intake and mixing zone under various flow conditions (such as low [e.g., 7Q10] and high [e.g., maximum monthly average] flow). The discharger should work with DEQ in determining the most appropriate flow regimes to use in the mixing zone model. Using these data, best professional judgment should be used in determining whether the mixing zone has the potential to interfere with the domestic water supply beneficial use.

2.3.2 Primary and Secondary Contact Recreation

Most waters in the state are presumed to support primary or secondary contact recreation uses. Thus, any mixing zone must generally protect these uses. Water bodies with contact recreation as a beneficial use are not to contain *E. coli* in concentrations exceeding a geometric mean of 126 *E. coli* organisms per 100 milliliters (mL) based on a minimum of five samples taken every 3–7 days over a 30-day period (IDAPA 58.01.02.251.01.a). However, Idaho's WQS prohibit authorizing a mixing zone for *E. coli* and any condition that impedes or prohibits recreation in and on the water body (IDAPA 58.01.02.60.01.d.vi).

When considering whether to authorize a mixing zone in an area designated or presumed for contact recreation uses, specific information is needed regarding the ability of the public to access the area affected and seasonality of use (e.g., swimming during late summer or whitewater rafting or kayaking during spring high flows). Additional information may be requested from the discharger regarding these uses when evaluating potential impacts of mixing zones.

2.3.3 Consumption of Aquatic Organisms

Although consumption of aquatic organisms (e.g., fish, mussels, crawdads) is not a distinct beneficial use in Idaho, it is considered to be part of recreation use through the activity of fishing in Idaho waters. Consumption of fish and other aquatic organisms is an important exposure pathway that is incorporated into the human health criteria applied to waters protected for either domestic water supply or recreational uses. Application of these criteria is based on the opportunity for exposure, not the actual occurrence of exposure. Evaluating existing or proposed mixing zones to determine whether there is unreasonable interference with the recreational beneficial use should consider the following:

1. Whether the discharge contains bioaccumulative pollutants;
2. Whether the harvest and consumption of aquatic organisms will be impeded by the mixing zone; and
3. The frequency with which organisms are harvested in the vicinity of the mixing zone.

Thus, the evaluation will consider the potential for harvest and consumption of exposed aquatic organisms within the mixing zone and downstream. The discharger may be required to submit information regarding the frequency of such activities or access points for such activities in the vicinity of the mixing zone. Using this and other information, DEQ staff will use best professional judgment in determining the appropriateness of a mixing zone for the pollutants of concern.

2.4 General Size and Location Requirements to Consider

Mixing zones must be sized and located so as to maintain protection of beneficial uses in the waterbody as a whole. Idaho's mixing zone policy lists specific requirements for the size and location of a mixing zone. However, DEQ has the discretion to depart from these requirements in certain circumstances. The following subsections discuss each of the size and location requirements for flowing and nonflowing waters.

2.4.1 Flowing Waters

2.4.1.1 Flow Requirement

As described in IDAPA 58.01.02.060.01.h, the size of a mixing zone should not exceed 25% of streamflow volume of the low-flow design discharge conditions (Table 3). EPA permit writers typically use 25% of low-flow design discharge conditions to establish a dilution factor when conducting an RPA. Once EPA provides this analysis to DEQ staff prior to issuing a draft 401 certification, DEQ staff will evaluate whether a mixing zone will be authorized consistent with WQS.

This size determination is accomplished through RPA and WQBEL back-calculations. Historical effluent data demonstrating a smaller mixing zone is achievable should be considered when lowering the mixing percentage. For example, if a discharge has no RPTE a criterion using 10% mixing, DEQ may authorize a mixing zone using 10% of the low-flow design discharge conditions for that parameter. Section 3.1 provides further guidance on establishing an appropriate mixing zone percentage.

DEQ may authorize a mixing zone that includes more than 25% of the volume of the low-flow design discharge conditions, provided the discharger demonstrates this larger mixing zone is needed and submits sufficient information illustrating the increased mixing zone size will not unreasonably interfere with, or cause danger to, the beneficial uses of the receiving water body (see section 2.6). Table 3 lists the low-flow discharge condition values that apply to mixing zones, as described in IDAPA 58.01.02.210.03.

Table 3. Low-flow design discharge conditions to use in mixing zone evaluations.

Criteria	Low Flow Condition	Explanation
Aquatic Life—Toxics[a]		
Acute toxic criteria (CMC)[b]	1Q10 or 1B3	1Q10: lowest 1-day flow with an average recurrence frequency of 10 years 1B3: biologically based low flow which indicates an allowable exceedance of once every 3 years
Chronic toxic criteria (CCC)[c]	7Q10 or 4B3	7Q10: lowest 7-day average flow with an average recurrence frequency of 10 years 4B3: biologically based low flow which indicates an allowable exceedance for 4 consecutive days once every 3 years
Aquatic Life—Nonconventionals[d]		
Temperature[e]	7Q10 or 4B3	7Q10: lowest 7-day average flow with an average recurrence frequency of 10 years 4B3: biologically based low flow which indicates an allowable exceedance for 4 consecutive days once every 3 years
Ammonia – Acute Criterion (CMC)[b]	1Q10 or 1B3	1Q10: lowest 1-day flow with an average recurrence frequency of 10 years 1B3: biologically based low flow which indicates an allowable exceedance of once every 3 years
Ammonia – Chronic Criterion (CCC)[c]	7Q10 or 4B3	7Q10: lowest 7-day average flow with an average recurrence frequency of 10 years 4B3: biologically based low flow which indicates an allowable exceedance for 4 consecutive days once every 3 years
Phosphorus	—[f]	
Human Health—Toxics[a]	Harmonic mean flow	Harmonic mean flow: long-term mean flow value calculated by dividing the number of daily flows by the sum of the reciprocals of those daily flows

[a] These low flows are specified in IDAPA 58.01.02.210.03.b. However as of October 2016, this element of Idaho's water quality standards has not been approved by EPA for Clean Water Act purposes.
[b] CMC: criterion maximum concentration
[c] CCC: criterion continuous concentration
[d] These low flows are not specified in Idaho WQS, and alternative flows may be used with DEQ approval.
[e] Low flows for the salmonid spawning beneficial use should be determined for the time period during which spawning and egg incubation occurs.
[f] DEQ will evaluate low flows for nutrients on a case-by-case basis. In total maximum daily loads, DEQ has used various estimates of low flows, including a seasonal average flow representative of the growing season (i.e., May to September) or an annual average flow.

Low stream flows are determined based on hydrologic records, often USGS flow records at a nearby gaging station. Other methods to estimate low flow at ungagged locations may be used, such as USGS StreamStats *http://water.usgs.gov/osw/streamstats/*.

In some instances a discharger may request DEQ consider alternative streamflow estimates in calculating the reasonable potential to exceed and any associated mixing zone authorization. DEQ would consider these requests in cases where it is clear that differing sets of circumstances exist which should be considered when developing effluent limits (e.g., different effluent flows, receiving water flows, hydrologic or climatic conditions). These requests must contain information sufficient to show that use of these alternatives do not impact beneficial uses of the water body. Sufficient information would likely include an extensive flow record and monitoring data of both the receiving water body and the effluent.

One possible approach to using alternative streamflow estimates includes calculating effluent limits and mixing zone size based on seasonal flows. This approach provides for tiered effluent limits based on an empirical data record for the receiving water body and effluent discharge. The use of seasonal limits in calculating has been sanctioned and employed in EPA permits over the years (EPA, 1996). However, this tiered approach would require dynamic modeling of the receiving water body and the effluent discharge to ensure that duration and frequency components of an associated criterion continue to be met. It would also require an extensive data record to model seasonal flows in the receiving water body.

Idaho's water quality standards allow for the flexibility of incorporating seasonal tiered effluent limits in discharge permits. Authorization of a mixing zone for these tiered effluent limits would be based on the same calculations associated with calculating the tiered limits and would likely fluctuate with the seasonal flows. For example, dilution ratios for tiers may be calculated and analyzed to determine critical periods in a case where high seasonal flows associated with run-off cause significant variability both in the receiving water body and the effluent flow. Critical dilution ratios may be calculated as the highest ratio expected to occur in a 4 day period once every 4 years corresponding to the biologically based water quality critical flows. These critical dilution ratios would then be incorporated into the effluent limit calculation to ensure compliance with duration and frequency components of the water quality criteria.

2.4.1.2 Width Requirement

A mixing zone should be sized such that the concentration of the constituent(s) being discharged should not exceed the applicable chronic criteria at greater than 25% of the stream width (IDAPA 58.01.02.060.01.h.i). A higher level of analysis should be used where this is a concern (see Section 3.4). The relevant width of the stream is the wetted width of the water flowing in the channel. Wetted width is a dynamic parameter that varies with flow. Additionally, at any given streamflow, channel widths and wetted widths also naturally change as one moves upstream or downstream. As channel gradients become steeper, flow often becomes more constricted and velocities increase. Likewise, channels tend to spread out and widen with decreasing gradients and lower flow velocities.

It is important, therefore, to define the flow regime (i.e., the water level) and the channel cross-section downstream where constituent concentrations meet the chronic criteria. At any given streamflow, channel widths and wetted widths naturally vary upstream and downstream of an

outfall. Open channel hydraulics models such as the Hydrologic Engineering Centers River Analysis System (HEC-RAS) may be used to define the wetted width and shoreline of the 7Q10 low flow. Mixing zone models, such as CORMIX, can be used to compare different levels of flow, the width and length of the effluent plume, and the appropriate cross-section where the low-flow wetted width would be established as a compliance point. Where aquatic life toxics criteria are considered, DEQ generally uses the 7Q10 to define the low-flow wetted-width and the location of the compliance cross-section. This value ensures the mixing of effluent plumes meets chronic criteria prior to becoming wider than 25% of the stream width at all flow conditions.

However, there may be instances where streamflow and velocity increases cause the effluent plume to travel greater distances before sufficient mixing occurs to meet criteria. Additionally, wider plumes may be observed at higher flows. Where the required mixing zone to meet chronic criteria approaches 25% of the stream width, additional studies and modeling may be necessary to predict the length, width, and amount of mixing at higher flow conditions.

2.4.1.3 Shore-Hugging Plumes

While DEQ understands EPA's position (1994) that shore-hugging plumes be avoided, Idaho WQS do not specifically prohibit shore-hugging plumes in flowing waters. However, in some cases, DEQ may significantly limit or even prohibit mixing zones to prevent adverse impacts to the environment and human health consistent with IPADA 58.01.01.060.01.b. and 060.01.d. Additionally, IDAPA 58.01.02.060.01.j.ii instructs outfall design to consider avoiding shore-hugging plumes where the littoral zone is a major supply of food and cover for migrating or rearing fish and other aquatic life or where recreational activities are impacted by the plume's contact with the shore.

Outfalls constructed at the bank generally result in shore-hugging plumes; most dischargers in Idaho have outfall structures located on the bank, perpendicular to streamflow. DEQ encourages, but does not require, diffusers for discharges to flowing waters. While DEQ recognizes there may be instances where installing a diffuser results in more harm than good, or does not result in any added environmental benefits, diffusers generally result in more rapid mixing, decreasing the area containing elevated concentrations and thus minimizing effects on beneficial uses. Mixing zone models such as CORMIX may be used to determine the likelihood of a mixing zone hugging a shoreline. For example, where beneficial uses like a domestic water supply intake structure or primary contact recreational area has the potential to encounter a proposed mixing zone.

2.4.2 Nonflowing Waters

Water bodies with a mean detention time of 15 days or greater are considered nonflowing. Detention time is calculated by dividing the mean annual storage volume by the mean annual flow rate out of the impoundment for the same time period. Nonflowing waters like lakes and reservoirs offer less mixing potential than streams or rivers and are at greater risk for some pollutants to interfere with the beneficial uses of a water body, including bioaccumulative pollutants and nutrients. As such, DEQ will review mixing zones within nonflowing waters with respect to flow and mixing and bioaccumulative pollutants.

2.4.2.1 Horizontal Area Requirement

For existing discharges to nonflowing waters authorized prior to July 1, 2015, the size of the mixing zone is not to exceed 10% of the nonflowing water body's surface area (IDAPA 58.01.02.060.01.h.iii). For all new discharges to nonflowing waters authorized after July 1, 2015, the size of the mixing zone is not to exceed 5% of the total surface area of the water body or 100 meters from the point of discharge, whichever is smaller (IDAPA 58.01.02.060.01.h.ii).

The discharger should provide an estimate of a nonflowing water body's minimum surface area during low-pool conditions (maximum drawdown). The horizontal (surface) area of the water body may be estimated by interpolating low-pool elevations with USGS topographic maps and/or other maps that delineate the water body's boundaries.

2.4.2.2 Additional Requirements for New Dischargers to Nonflowing Waters

New dischargers to nonflowing waters are required to use diffusers and design the outfall such that the plume is not shore-hugging (IDAPA 58.01.02.060.01.h.ii.2).

2.4.3 Multiple Mixing Zones

IDAPA 58.01.02.060.01.e states multiple nested mixing zones may be established for a single discharge (a single outfall), each being specific for one or more pollutants contained within the discharge. For example, DEQ may authorize a mixing zone for zinc that uses 25% of the low-flow design discharge conditions and for the same outfall authorize a mixing zone for copper that uses 15% of the low-flow design discharge conditions.

When multiple points of discharge for a single activity (discharge facility) are evaluated, DEQ will consider the treatment processes, concentrations of the pollutants of concern, and the locations of the outfalls. Where these individual mixing zones overlap or merge, the sum of the (multiple) mixing zones from those discharge points must not exceed the area and volume that would be allowed for a single point of discharge (IDAPA 58.01.02.060.01.f).

When these individual mixing zones do not overlap or merge, DEQ may authorize individual mixing zones. The cumulative impact of these discharges should not cause unreasonable interference with the beneficial uses of the receiving water body. Additionally, adjacent mixing zones from independent activities are not permitted to overlap (IDAPA 58.01.02.060.01.g).

The mixing zone area and volume are generally determined through modeling, as discussed in section 4.

2.5 Requirements for Submerged Discharges

Idaho WQS do not require a submerged discharge point for new or existing discharges into flowing waters. However, a submerged discharge is preferable because it enhances hydrodynamic mixing. For new discharges into nonflowing waters, diffusers are required (IDAPA 58.01.02.60.01.h.ii.3). A description of the discharge location and depth should be provided by the applicant when mixing zones are being considered.

2.6 Varied Mixing Zone Sizes

IDAPA 58.01.02.060.01.i allows mixing zones to vary from the limits of subsection 060.01.h. A smaller mixing zone may be needed to avoid an unreasonable interference with, or danger to, a beneficial use. Conversely, a larger mixing zone that does not interfere with beneficial uses and meets the other requirements of section 060 may be authorized when the discharger provides an analysis that demonstrates a need given siting, technological, and managerial options.

Siting options include the location point of discharge, which receiving water body as well as where in the receiving waterbody. While this is typically an option for new discharges, it may be a consideration during facility upgrades. For example, a discharger may choose the use of diffusers or a longer pipe to discharge to a larger receiving water body rather than discharge to the water body adjacent to the treatment facility.

Technological considerations include treatment types and process alternatives that would improve effluent quality. For example, a treatment option may be to switch from chlorination to UV disinfection; a process alternative may be the use of a less toxic chemical.

Managerial options typically involve water management such that a lesser volume of effluent is discharged, levels of treatment, or improving process efficiency so that less wasted is generated per unit of production.

2.7 Other Considerations

2.7.1 Assimilative Capacity

Mixing zones will not be authorized for pollutants for which a water body is considered impaired unless there are available wasteload allocations (e.g., specifically allocated for a discharger or included in a reserve for growth) in an approved total maximum daily load (TMDL) or other applicable plans or analyses (such as 4b implementation plans, watershed loading analyses, or facility-specific water quality pollutant management plans) that demonstrate that there is available assimilative capacity. The most current EPA-approved Integrated Report should be used to determine the beneficial use support status of the receiving water body (see *www.deq.idaho.gov/integrated-report*).

In assessing assimilative capacity, it is also prudent to consider upstream permitted discharges, which may not yet be discharging at their permitted maximum loads. If this is the case, basing assimilative capacity on what is presently or recently observed is likely to result in overshooting assimilative capacity when all discharges in a watershed reach their permit limits. This broader look at assimilative capacity is known as a watershed-based approach to permitting and its application can avoid future impairment, the need to develop a TMDL, and future cut backs in permitted effluent limits.

One example of a watershed-based approach to permitting was a metals analysis included in an NPDES Fact Sheet for several wastewater discharges to the Spokane River. EPA performed a separate analysis to determine if the combined discharges of zinc from the City of Coeur d'Alene, the City of Post Falls, and the Hayden Area Regional Sewer Board have the reasonable

potential to cause or contribute to excursions above Washington's water quality criteria for zinc at the State line.

Zinc excursions would still exist at the State line even if the Idaho dischargers ceased discharging entirely, or discharged no zinc. However, the water quality criteria for zinc become less stringent with increasing hardness. Because the effluents from the three point sources to the Spokane River in Idaho are harder than the receiving water, the Idaho dischargers create loading capacity for zinc (by raising the hardness and in turn the water quality criteria) at the State line. Using available information and conservative assumptions, EPA determined that, by discharging relatively hard water, the three Idaho point sources reduce the magnitude of excursions above zinc water quality standards at the State line. In other words, the Idaho point sources' discharges of relatively hard water to the Spokane River create more zinc loading capacity than they use by discharging zinc. Therefore, the Idaho dischargers do not have the reasonable potential to cause or contribute to excursions above Washington's water quality standards for zinc at the State line, and it is therefore not necessary to impose zinc effluent limits on the Idaho point sources that are more stringent than those necessary to meet Idaho water quality standards at the end-of-pipe (Nickel, 2007a).

2.7.2 Temperature

When evaluating thermal plumes, DEQ will consider whether the heat in the discharge will cause unreasonable interference with, or danger to, beneficial uses as well as, the limitations expressed in *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (EPA 2003). Thermal plumes should not cause: impairment to the integrity of the aquatic community, including interfering with successful spawning, egg incubation, rearing, or passage of aquatic life; and, thermal shock, lethality, or loss of cold water refugia (IDAPA 58.01.02.060.01.d). To minimize or avoid these types of unreasonable interference, the following will be considered when conducting a mixing zone analysis (EPA 2003):

- Within 2 seconds of plume travel from the point of discharge, maximum temperatures should not exceed 32 ºC.
- The cross-sectional area of the receiving water body exceeding 25 ºC should be limited to less than 5%.
- The cross-sectional area of the receiving water body exceeding 21 ºC should be limited to less than 25%, or if upstream temperatures exceed 21 ºC, then at least 75% of the receiving water body should not have temperature increases of more than 0.3 ºC.
- In spawning and egg incubation areas, the maximum weekly maximum stream temperatures should not exceed 13 ºC, or the temperatures should not be increased by more than 0.3 ºC above ambient stream temperatures during times when spawning and incubation occur.

2.7.3 Points of Compliance as Alternatives to Mixing Zones

DEQ may establish points for monitoring compliance with ambient water quality criteria when the nature of the discharges precludes a mixing zone analysis. Some section 404 dredge and fill activities, stormwater, and nonpoint source discharges are intermittent and diffuse. For these types of discharges, a point of compliance may be established at a reasonable distance from the discharge.

For flowing waters, a down current point of compliance should be less than or approximately equivalent to the width of the receiving water body. For non-flowing waters, a point of compliance should ensure no unreasonable interference, or danger to, the beneficial uses of the receiving water body; it should be established at a site-specific radial distance from the activity and based on the magnitude, frequency, and duration of the discharge. Section 5 discusses monitoring that may be included as a condition of the 401 certification or permit.

2.7.4 Effluent-Dominated Waters

In some cases, the volume of discharge may provide a benefit (e.g., flow augmentation) to the beneficial uses of the receiving water body, and this benefit would be lost if the discharge were to cease. In these instances, DEQ may authorize mixing zones that use more than 25% of the stream volume at low flow as long as the mixing zone does not unreasonably interfere with the beneficial uses of the receiving water body.

3 Mixing Zone Approval Process

The following process will be followed when determining whether to authorize a regulatory mixing zone for pollutants in NPDES permits:

1. EPA performs a reasonable potential analysis through reasonable potential to exceed calculations using 25% of the low-flow receiving water volume for dilution (i.e., a 25% mixing zone). The low-flow statistic used can vary, but is usually a 1Q10 for the CMC and a 7Q10 for the criterion continuous concentration (CCC). EPA develops effluent limits for pollutants that exceed water quality criteria.

   When establishing the appropriate size of a mixing zone in nonflowing waters, a complex level of analysis must determine the volume of a receiving water body based on a percentage of the water body's surface area.
2. DEQ receives the draft permit and spreadsheet used by EPA to calculate limits. DEQ will work with EPA permit staff to adjust the size of the regulatory mixing zone so that it is no larger than necessary considering siting, technological, and managerial options available to the discharger.
3. Additionally, DEQ will perform a mixing zone analysis to determine the size of the plume and its effects on the receiving water body.
4. Once regulatory mixing zones are determined, DEQ requests EPA to redraft the permit using new mixing zone sizes for dilution and authorizes these mixing zones in the draft 401 certification of the permit.

Where a larger mixing zone is needed by the discharger, the process will begin with an evaluation of the siting, technological, and managerial options analysis provided by the discharger.

3.1 When are Mixing Zones Considered?

Mixing zones are considered when EPA determines through the NPDES permitting process that WQBELs are necessary because a discharge does not meet water quality standards after

accounting for dilution. Idaho is pursuing delegation of the NPDES permitting authority. In the interim, EPA Region 10 issues NPDES permits in Idaho and requests the state certify there is reasonable assurance the permit will comply with Idaho WQS (per section 401 of the CWA). This certification includes authorization of any proposed mixing zones and the applicable WQBELs. To begin that process, DEQ works with the applicant to gather the information on the "Mixing Zone Data Needs Form" (see Appendix B).

When first determining the RPTE a state water quality standard and whether a WQBEL is necessary, EPA's draft permits typically contain a dilution factor, where the mixing zone percentage is 25% of the low-flow volume of the receiving water. That low flow is typically a 7Q10, 1Q10, or a biologically based flow (Table 3). It is incumbent upon DEQ, through the 401 certification process, to determine whether the assumed mixing zone percentage used to calculate the dilution factor is the appropriate size mixing zone to be authorized.

Mixing zones in non-flowing waters must be authorized using the percentage of the receiving water body's surface area and for new discharges, the linear distance from the outfall. DEQ has limited experience making this type of determination as the majority of discharges in the state are to flowing waters. Therefore, authorizing a new or expanding mixing zone in nonflowing waters will always require a complex level of analysis.

A permitted discharge to Lake Pend Oreille is one example where a site specific, complex level of analysis was required to protect beneficial uses of the receiving water body. The primary concern was ensuring the plume would not hug the shoreline. The analysis determined the portion of the lake functioned like a flowing water. That is, the contributions to the lake from the Clark Fork River were found to be equivalent to the amount of water leaving the reservoir. In this instance it was appropriate to authorize a smaller percent mixing zone based on volume and not surface area given the surface area of the water body is roughly 7,000 to 9,000 acres.

Where the receiving water body is non-flowing water, the process for authorizing a mixing zone requires knowing the surface of the receiving water body and determining the area of the mixing zone which exceeds applicable criteria. This will likely require modeling, and thus additional information, including the water body's bathymetry and storage capacity at low pool elevation.

Once the dilution factor and any necessary WQBELs are determined, DEQ may need to complete a mixing zone plume analysis (see section 3.4). This analysis will evaluate how the discharge entrains sufficient water to achieve the desired mixing percentage. The resulting mixing zone from the discharge will be evaluated to determine its physical size (length, width, depth); the location of the mixing zone (where the CMC and CCC are met); drift time through the mixing zone; and any interactions that may occur with spawning areas, ecologically sensitive areas, water intakes, swimming areas, etc. Once DEQ determines that the mixing zone analysis is adequate, the new mixing zone percentage and associated dilution factor can move forward in the permitting process.

Once established, EPA uses the new dilution factors, mixing zone percentage, and the projected effluent characteristics to reevaluate if the discharge has a reasonable potential to cause or contribute to an exceedance above the applicable water quality criteria at the boundary of the mixing zone. If necessary, the dilution factors will be used to calculate new WQBELs. DEQ staff should verify the mixing zone calculations and ensure that the mixing zone will not adversely

affect the aquatic environment. For pollutants with no RPTE, the assumed mixing zone (i.e., where P = 0.25 in the dilution factor) should be evaluated and minimized where appropriate. The mixing zone for these pollutants should be authorized in the 401 certification and may include specific monitoring requirements.

In part, this guidance is intended to facilitate greater upfront involvement by DEQ staff, working with EPA, in mixing zone evaluations. Section 3.2 describes the process for authorizing mixing zones in new permits, while section 3.3 addresses the procedures for reissued permits.

3.2 Procedures for New Permits

The process for new permit development is shown in Figure 2. Applicants should submit an NPDES application to EPA as well as the 401 program coordinator and the appropriate DEQ regional office. Submitting the application to DEQ will facilitate and expedite the 401 certification process. This certification includes authorization of any proposed mixing zone used in the RPA and WQBEL development. To begin that process, DEQ works with the applicant to gather information necessary to authorize a mixing zone (see Appendix B, Mixing Zone Data Needs Form).

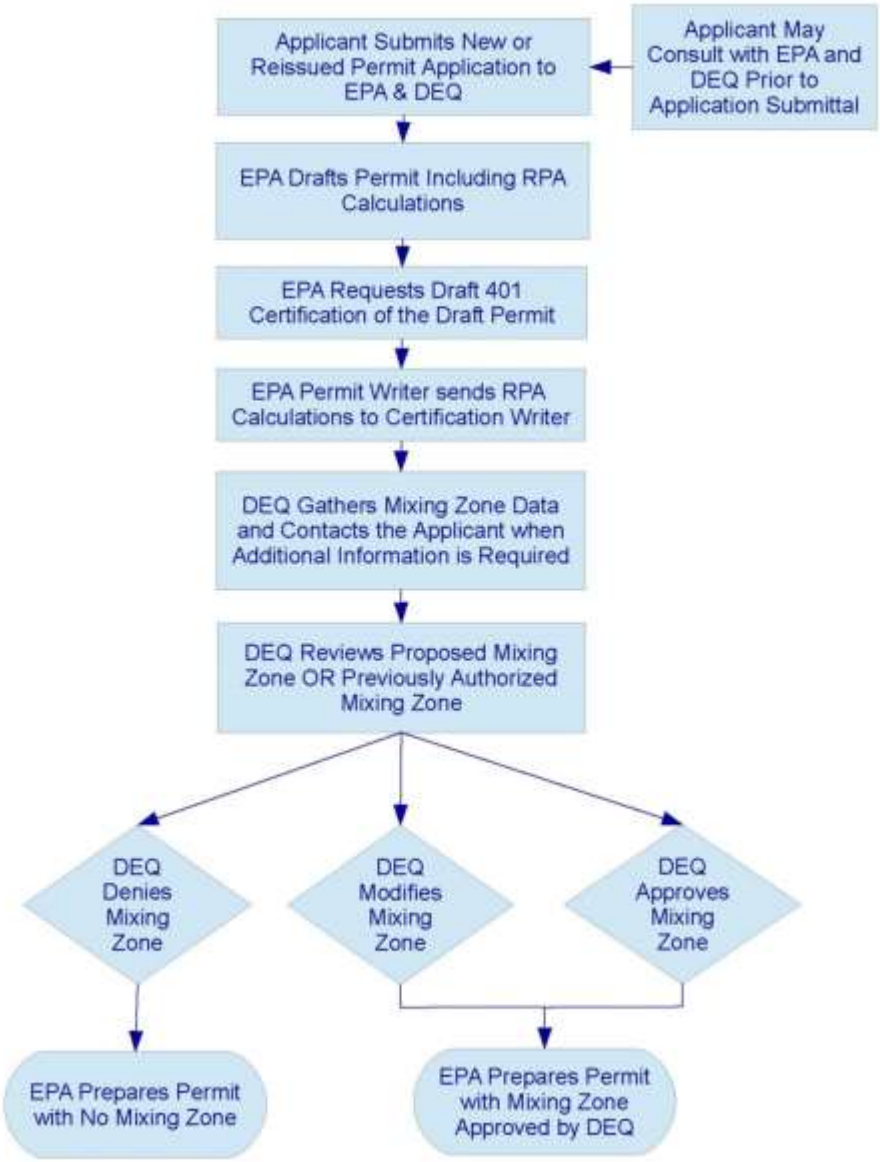

Figure 2. Mixing zone process for new or reissued permit applications.

3.3 Procedures for Reissued Permits

The procedures described below are intended to facilitate greater coordination between EPA and DEQ in reissuing permits with mixing zones, as summarized in Figure 2. EPA should share reissuance applications with DEQ where a mixing zone has previously been granted.

Where EPA proposes to re-issue an NPDES permit with an existing mixing zone, further analysis may be required to determine whether that mixing zone is the appropriate size. DEQ should consider, at a minimum, the previous 5 years of effluent monitoring data to determine whether the existing mixing zone is appropriately sized. In making such a determination based

on facility performance, the preferred approach is to statistically evaluate performance data provided by the discharger. The 95th percentile of the effluent data should be used to evaluate the appropriate mixing zone percentage, which should be lowered (and the dilution factor adjusted) to the level where any lower percentage of dilution would cause an exceedance of WQS. At that point, the smaller mixing zone may be authorized in the certification. Mixing zone percentages are rounded up to the nearest whole number (e.g., analysis demonstrates a 0.05% mixing zone is necessary, the percent authorized should be 1%).

Should the historic effluent data show that limits using 25% mixing when calculating the dilution factor are lower than the 95th percentile level, then DEQ and the discharger should investigate the feasibility of treatment upgrades at the facility to achieve better effluent quality and whether a compliance schedule is appropriate. A larger mixing zone may be authorized where the discharger and DEQ agree considering siting, technological, and managerial options available to the discharger. These options include site-specific conditions, feasibility in regards to treatment, and total options the discharger may have, including costs.

Because mixing zone modeling is typically based on a series of assumptions that are often tested and refined with water body specific data, DEQ may request the discharger provide additional information if necessary for reviewing the appropriateness of the existing mixing zone. New mixing zone calculations will be needed to address water quality criteria revisions or availability of additional data regarding effluent quality/flow, background water quality, or receiving water hydrodynamics.

For mixing zones based on aquatic life criteria, DEQ will consider any biological data collected for the mixing zone to verify there are no adverse impacts on aquatic life outside the mixing zone.

3.4 Mixing Zone Analysis Level of Effort

DEQ recognizes that not all discharges merit the same level of concern. Some discharges will demand an extensive mixing zone analysis to evaluate the potential for chemical, physical, and biological impacts. Furthermore, not all discharges require modeling to determine the size, configuration, and location of the mixing zone. Rather, the intent of Idaho's mixing zone policy can be met through various levels of effort depending on the nature of the discharge and the characteristics of the receiving water. These conditions are described in further detail in section 3.4.1. DEQ has identified three levels of analysis involved in mixing zone analysis:

- Level 1—Simple
- Level 2—Moderate
- Level 3—Complex

Figure 3 depicts the process for determining the appropriate level of analysis. The data requirements for each level of analysis are presented in Appendix C. DEQ retains discretion in departing from these guidelines. For example, DEQ may choose to implement a complex or level 3 analysis of a mixing zone for a minor discharger where there is known potential for unreasonable interference, or danger to, beneficial uses exist.

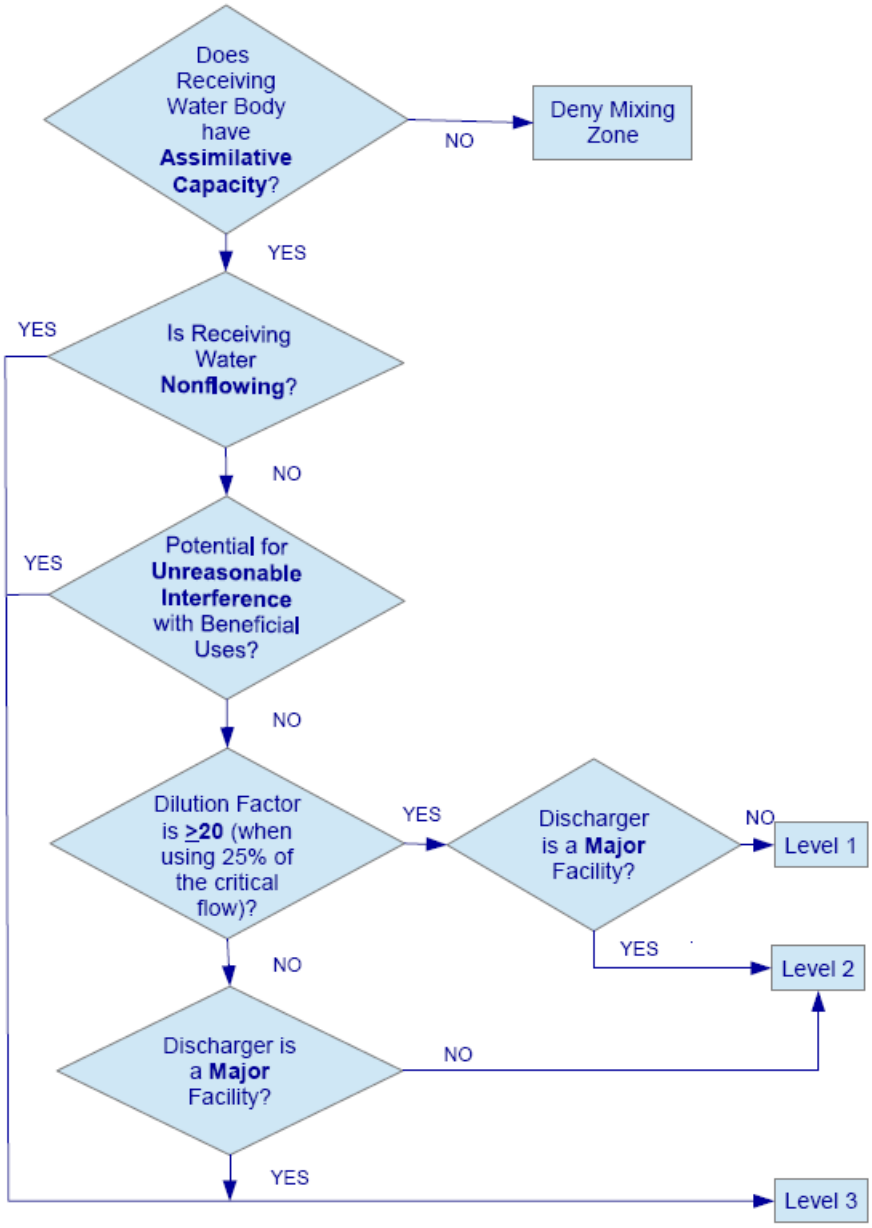

Figure 3. Decision flow chart for determining level of analysis.

3.4.1 Determining Level of Analysis

The level of analysis is determined by looking at the potential environmental risk, the dilution factor, and the type of discharge facility.

3.4.1.1 Unreasonable Interference with, or Danger to, Beneficial Uses

There may be situations where a discharge has the potential for unreasonable interference with, or danger to, the beneficial uses of a water body. Such situations may include, but are not limited to, the following:

1. Areas used for spawning when those areas are considered to be necessary for the overall success of the population in that water body
2. Pollutants significant to human health with the potential to impinge on a drinking water intake
3. Areas heavily used for contact recreation purposes (e.g., public swimming beaches) where discharges occur during the recreation season
4. Areas supporting species of special concern
5. Priority persistent bioaccumulative pollutants (see section 2.2.7 and *www.deq.idaho.gov/media/60160659/bioaccumulative-pollutants.pdf*)
6. When dilution is severely limited (e.g., a dilution ratio <1)

Situations with a potential for unreasonable interference or danger to beneficial uses necessitate a level 3 mixing zone analysis.

3.4.1.2 Dilution Factor

If the dilution factor is equal to or greater than 20, a level 2 or 3 mixing zone analysis may not be required (depending on other site-specific factors), and the appropriate percentage of the low flow may be automatically used in the permitting process. See Section 1.2 for an explanation of the variables used to calculate a dilution factor.

The dilution factor calculated using 25% of the low-flow design will only be used to determine the appropriate level of effort that should be conducted. If a level 1 analysis is sufficient, then the appropriate proportion of streamflow according to the "Flow requirement" discussion in section 2.4.1 must be used in the evaluation of RPTE and subsequent calculation of WQBELs.

However, if a level 2 or 3 analysis is appropriate, then the dilution factor that is modeled at the edge of the mixing zone must be used in the RPA and, when appropriate, in calculating WQBELs. This distinction is necessary because dilution factors calculated from the equation in section 1.2 will likely be different from those obtained through modeling.

3.4.1.3 Type of Facility

EPA classifies facilities as major or minor. Facility design flow is the primary consideration in this classification scheme for POTWs. If the design flow is greater than or equal to 1 million gallons per day, or poses a potential or actual threat to human health or the environment, then EPA classifies the POTW as major. Industrial facilities are classified as major or minor based on a scoring system that considers a variety of factors including standard industrial classification code, type of effluent constituents (e.g., toxics), and available dilution.

3.4.2 Level 1—Simple

The simple (or mass balance) approach represents the simplest form of calculating an appropriate dilution factor for the RPA and WQBEL calculations. This level of analysis is appropriate when both of the following conditions are met:

- There is no known potential for unreasonable interference with, or danger to, beneficial uses or lowering of water quality.
- The discharger is considered minor, and the dilution factor is greater than or equal to 20.

Limited data are needed for this analysis, and no modeling is required. In most situations, pre-discharge biological data will not be required, and although ambient water quality data are desirable, DEQ recognizes that they may not be available and may require ambient monitoring during the permit cycle. Where a proposed discharge lacks sufficient effluent data, data from a comparable facility may be used to establish a WQBEL.

For minor dischargers with a dilution factor greater than 20, the mixing zone percentage may be adjusted to no larger than necessary by back calculating the dilution factor downwards toward the value of 20.

3.4.2 Level 2—Moderate

The moderate mixing zone analysis may be used when there is a low level of risk to the public and aquatic environment. This level of analysis is appropriate when the following conditions are met:

- There is no known potential for unreasonable interference with beneficial uses.
- The dilution factor is greater than or equal to 20, and the discharger is considered major.
- The dilution factor is less than 20, and the discharger is considered minor.

Although more extensive than the level 1 analysis, this level has relatively minimal data needs. Modeling is necessary to understand the location and configuration of the mixing zone, but some of the modeling inputs can be estimated rather than measured (Appendix C). Similar to level 1, predischarge biological data and ambient water quality data may not be required.

3.4.3 Level 3—Complex

This level of analysis is appropriate when there is a moderate or high level of risk to the public and aquatic environment. This level of analysis is appropriate when one of the following conditions are met:

- There is potential for unreasonable interference with beneficial uses (e.g., a water body that is effluent dominated).
- There is no known potential for unreasonable interference with beneficial uses, the dilution ratio is less than 20, and the discharger is considered major.

This level of analysis requires more of the model inputs to be measured rather than estimated (Appendix C). Some flexibility does exist, depending on the situation and reliability of estimates. Some estimates may be based on a facility type (e.g., modeling for a new POTW with a pretreatment program), while other inputs may be specific to a facility and require measurement. For example, a receiving water body may become highly channelized during critical low flows, requiring the modeler to obtain numerous downstream bathymetric cross-sections. Pre-discharge (or upstream/downstream) biological and chemical data for the receiving stream will be required prior to authorizing a mixing zone for new discharges.

3.5 Mixing Zone Review and Approval

When mixing zones are proposed, EPA and DEQ will work together during NPDES permit issuance. DEQ staff should review the mixing zone data needs form (Appendix B) for

completeness and request from the discharger any additional data required to complete the mixing zone authorization. After the necessary information has been gathered, DEQ staff will verify mixing zone percentages used in the dilution factor and/or modeling. After the mixing zone has been verified or calculated, EPA staff will apply the appropriate dilution factor(s) to the RPA and, if necessary, calculate WQBELs.

The fact sheet and water quality certification will include DEQ's mixing zone decision. At a minimum, the fact sheet or the water quality certification should include the dilution factor used; the size, configuration, and location of the mixing zone; and, where appropriate, calculations showing an analysis regarding the size considerations in IDAPA 58.01.02.060.01.h when a level 2 or 3 analysis is conducted. A three-dimensional representation overlaying the mixing zone with the receiving water may also be provided. Multiple mixing zones and ZIDs should be displayed, where appropriate.

> A fact sheet is a document prepared by EPA that accompanies an NPDES permit. The fact sheet summarizes the principle facts and issues (scientific, policy, methodological, and legal) considered in preparing the draft permit. A water quality certification is a decision by the state of Idaho that there is reasonable assurance the permit complies with all applicable requirements of the CWA and state water quality standards.

The public will have an opportunity to comment on the authorized mixing zone during the public comment period(s) for the draft NPDES permit, its associated fact sheet, and draft water quality certification. DEQ will address comments related to the authorized mixing zone(s) prior to issuing the final water quality certification.

4 Mixing Zone Determinations

Mixing zone determinations, especially those requiring more complex levels of analysis, can be aided by the use of models and/or dye studies. Available models and associated inputs are discussed below.

4.1 Background on Mixing Zone Modeling

The hydrodynamics of mixing when two streams of water come together can be complex. How well waters mix largely depends on the forces governing water movement. An effluent discharged from a pipe or side channel will have jet forces associated with it created by the volume of water, the size of the pipe or channel opening, the angle or direction of flow, and the water's buoyancy (relative density). The receiving water also has its own forces: velocity and volume, gradient, and channel dimensions and characteristics.

Hydrodynamic models have been developed in an effort to characterize these forces and predict how the two water bodies will mix, the rate at which they will mix, and the size of the resulting plume in the receiving water (length, width, depth). Models help determine how fast pollutants dilute to specific levels and when and where certain concentrations exist. We can divide models into two basic categories: those that predict the results of immediate mixing (near-field mixing) where jet forces are at work and far-field mixing where more passive diffusion or ambient mixing occurs. Pollutants added to a receiving water through discharge may already exist as

background concentrations in that receiving water. Once the discharge is completely mixed, there will be a new equilibrium or new concentration for the pollutants moving downstream.

The distinction between near-field and far-field is made purely on hydrodynamic grounds and is unrelated to any regulatory mixing zone definitions that address prescribed water quality criteria. In many practical cases, the regulatory mixing zone may include only near-field hydrodynamic mixing processes. However, in some instances, the mixing zone may extend into the far-field. For example, a small source in a strong cross flow may rapidly enter the far-field region well before the edge of a regulatory mixing zone. Thus, in principle, the entire gamut of mixing processes—ranging from the near-field to the far-field—should be considered for individual mixing zone analyses.

4.1.1 Near-Field Mixing

The first stage of mixing is achieved by discharge jet momentum and buoyancy of the effluent. This stage is particularly important in lakes, impoundments, and slow-moving water bodies since ambient mixing in those systems is minimal. In the absence of receiving water turbulence, horizontal or nearly horizontal discharges will create a clearly defined jet in the water column. When the discharge flow encounters a boundary such as the surface, the bottom, or an internal ambient density stratification layer, the near-field region ends and the transition to the far-field begins. In simple terms, the near-field region is typically the region that is controlled by the characteristics of the discharge itself (discharge flow rate, port diameter, etc.).

4.1.2 Far-Field Mixing

Beyond the near-field, mixing is controlled by passive diffusion and ambient turbulence (i.e., spatial variations in the water body's velocity field). If little discharge-induced mixing is associated with the jet action of the discharge, then continued mixing must be accomplished by ambient forces, which can result in much larger mixing zones. This situation is typical in nonflowing waters (lakes and reservoirs). Once the discharge interacts with a boundary such as the banks, the surface, or the bottom of the stream, the mixing processes are primarily a function of turbulence. The discharge in the far-field (see Figure 4) loses its "memory" of its initial conditions, and mixing is mainly a function of the ambient conditions (ambient velocity and density field, channel roughness and meanders, etc.).

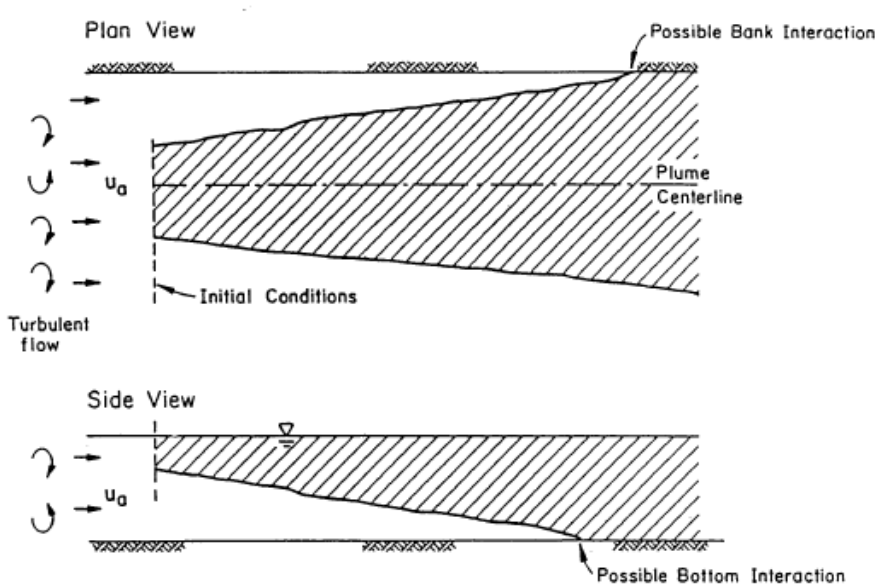

Figure 4. Far-field plume, passive ambient diffusion processes (Jirka et al. 1996).

4.2 Available Models

A wide variety of mixing zone models exists for evaluating the mixing behavior and plume dynamics of a point source discharge. No single model is appropriate for every discharge situation. Each model has its own set of strengths and weaknesses. It may be appropriate to use more than one model to evaluate mixing and dilution if more than one is available to the modeler. DEQ prefers EPA-supported models such as CORMIX; however, DEQ may consider other models (e.g., Visual Plumes) if they are more suitable for the site-specific conditions. If the applicant wants to use a model not discussed in this manual, it is highly recommended that the applicant discuss this with DEQ prior to modeling the discharge.

4.2.1 Near-Field Dilution Models

Buoyant jet models, such as those in CORMIX, predict dilution by stringing together a series of semi-empirical entrainment formulations. The region of applicability of the entrainment formulations is determined by various length scales including the buoyancy and momentum length scales. The entrainment formulations are referred to as semi-empirical since their general functional dependencies are derived theoretically but various coefficients must be determined from observations. A length scale is a scaling estimate based on dimensional analysis arguments that identifies the region of influence of a particular physical process. Each length scale is a distance along the trajectory where one parameter predominates (i.e., controls the flow). Once strung together by this analysis, the length scales should describe the relative importance of all parameters—discharge volume flux, momentum flux, buoyancy flux, ambient cross flow, and density stratification—throughout the trajectory. For example, the solution for a pure jet can be applied as an approximate solution to that portion of a buoyant jet in a cross flow where jet momentum dominates the flow. Likewise, the results for a pure plume can be applied to the buoyancy-dominated regions for the buoyant jet. The length scales are linked by appropriate transition conditions to create a path for the trajectory through the completion of initial dilution.

CORMIX is a commercially available mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones resulting from continuous point source discharges. CORMIX emphasizes the role of boundary interaction to predict steady-state mixing behavior and plume geometry. The CORMIX methodology contains systems to model single-port and multiport diffuser discharges, as well as surface discharges of conventional or toxic pollutants. Effluents considered may be conservative, nonconservative, or heated or contain suspended sediments.

CORMIX uses a data-driven approach to simulation model selection. It is comprised of about 50 flow modules, each with their own formulae or algorithms, and more than 100 possible distinct flow classifications. Based on the input data the user enters to describe the discharge and ambient environment, the system selects the proper choice of model to represent the physical mixing processes likely to occur within the mixing zone. The model selection procedure is both automated and fully documented by a rule-based system that screens the input data for internal consistency and compliance with model formulation assumptions. The system contains logic to reject cases where no reliable model exists for the given discharge situation and will warn the user in cases where the simulation occurs but results may be unreliable. The internal model selection procedure is fully documented by extensive, published, peer-reviewed scientific research. Statistical tools are readily available to evaluate model performance with available laboratory and field data on mixing predictions.

Visual Plumes (VP) (Baumgartner et al. 1994; Frick et al. 2003) is another initial dilution model available for analyzing mixing zones. It is freely available from the EPA Center for Exposure Assessment Modeling at *www2.epa.gov/exposure-assessment-models/visual-plumes*. VP can list salinity, temperature, and current variations at different depths. VP simulates single and merging submerged plumes in arbitrarily stratified ambient flow and buoyant surface discharges. VP addresses the issue of model consistency in a unique way, by including other models in its suite of models. In this way, it promotes the idea that in the future, modeling consistency will be achieved by recommending particular models in selected flow categories. VP includes the following models:

> CORMIX is available for free testing and evaluation from Mixzon, Inc., at *http://www.mixzon.com/*.

- Davis, Kannberg, and Hirst model for Windows (DKHW) that is based on the universal Davis, Kannberg, and Hirst density model (UDKHDEN) (Muellenhoff et al. 1985)
- Prych, Davis, and Shirazi surface discharge model (PDS) (Davis 1999)
- Three-dimensional updated merge model (UM3) based on the updated merge model (UM)
- Near-field model (NRFIELD) based on the Roberts, Snyder, and Baumgartner length scale model (RSB)

4.2.2 Far-Field Modeling Frameworks

The far-field models are designed to track the contaminant concentration along the plume of the discharge in areas of the receiving water where mixing is dominated by ambient fluid turbulence. Where far-field mixing is a concern, cumulative discharge centerline (defining cumulative changes in water quality) may need to be established. The CORMIX model is recommended as a

primary modeling framework for near-field analysis and far-field simulation since it has the capability of performing both near- and far-field mixing zone calculations (ref., http://www.mixzon.com/docs/UserManuals/FFL_UM/FFL_UserManual/).

4.3 Data and Information to Support Mixing Zone Analysis

The reliability of the predictions from any of the modeling techniques depends on the accuracy of the data used in the analysis. The minimum data required for model input include receiving water characteristics (flow, channel morphology, and background concentrations); effluent characteristics (flow and concentrations); and outfall design information. Appendix C lists the type of information needed for each level of analysis.

The discharger or DEQ may gather the necessary data, conduct the modeling, and prepare a summary of the modeling results. Where the discharger conducts the modeling, the discharger should include a map of the facility and its discharge point. At a minimum, the map should include other discharges within 0.5 miles, public access points, known spawning locations, drinking water intakes within 0.5 miles, and diversions. DEQ encourages gathering information from outside the 0.5 miles if the modeled mixing zone extends further that 0.5 miles or contains a bioaccumulative pollutant. DEQ will review the information provided by the discharger and determine whether the resulting mixing zone complies with Idaho WQS. The discharger is encouraged to consult with DEQ early in the process to ensure that DEQ concurs with the modeling approach.

4.3.1 Analytical Methodologies

Where possible, analytical methods listed in 40 CFR Part 136 should be used to measure pollutants in the effluent and receiving water body. Further, the detection limits and reporting limits should be sufficiently low to ensure that concentrations of concern can actually be reliably measured. Of particular concern are chemicals with very low water quality criteria values such as cadmium. EPA's Office of Science and Technology is a good source for information regarding analytical methods and their detection limits.

4.3.2 Receiving Water Morphology/Hydrology

Receiving water data would ideally include the following:

- Bathymetry in the vicinity of the discharge site
- Seasonal water temperature ranges or vertical temperature profile information for deeper lakes and reservoirs
- Ambient low flows
- Current information from direct measurements or inferred from water body ambient discharge and cross-sectional area

In practice, existing ambient water data may be very limited. In some cases, estimated values for the data may be acceptable (e.g., measures of discharge and channel geometry could be used to estimate currents). If data are limited, DEQ may require field sampling to gather the necessary data for either conducting or verifying the mixing zone modeling analysis. The following

paragraphs briefly describe sampling work that may be required to gather stream geometry and hydraulic data.

4.3.2.1 Channel Geometry

Channel geometry data are used to define the stream configurations, regardless of the particular model being used. The basic types of channel geometry data include the following:

1. Variation of channel width and cross-sectional area with depth
2. Bottom slope (or bed elevations)
3. Variation of wetted perimeter or hydraulic radius with depth
4. Bottom roughness coefficient (Manning's n)

Variation of water depth with flow will be discussed in the next subsection. The four parameters listed above may be assumed constant for the section of the river being modeled (i.e., the river is modeled as a rectangular box). However, these parameter values should be defined when low-flow conditions drastically change the receiving water body's channel geometry and its ability to assimilate the effluent. Length and average slope over long distances can be determined from topographic maps, while the other variables usually require field surveys. The level of detail required in describing the stream geometry depends on the amount of variability in the system and whether the mixing zone is expected to extend into the (hydrodynamic) far-field.

For streams with uniform slopes and cross-sections over the study area, only a few transects will be necessary. In areas where the channel geometry varies widely, the stream should be divided into a series of representative reaches, and sufficient transects should be measured along each reach to adequately characterize the geometry. Three to five cross-sections could be measured along each reach, and the results could be averaged to define the reach characteristics for the channel. At a minimum, one representative cross-section should be measured in each reach. Some pool and riffle streams may require dye studies and measuring as many cross-sections as possible to obtain adequate stream geometry. Where modeling (e.g., CORMIX) demonstrates the mixing zone will extend into the far-field, a cumulative discharge centerline may need to be established.

4.3.2.2 Channel Hydrology

Hydraulic data are needed to define the velocities, flows, and water depths for mass transport calculations. As indicated in section 2.4.1, mixing zone evaluations must consider low flows of the receiving water body. To determine low-flow values where an extended record of flow data at or near the discharge point is available, the EPA Office of Research and Development's DFLOW program, which can be downloaded free of charge, may be used. Alternatively, the USGS SWSTAT or Idaho StreamStats may be used. Other statistical methods can be proposed by dischargers in consultation with DEQ.

Both DFLOW and SWSTAT rely on the availability of long-term flow data. These models require at least 3 years, and preferably 10 years, of flow data to provide reliable statistical results. Such data may be independently collected by the discharger or another party within the watershed. Alternatively (as well as to verify discharger data), long-term flow data may be available if a nearby USGS stream gage is available.

4.3.3 Receiving Water Quality

Background water quality information is desirable to thoroughly evaluate mixing zones. Depending on the quantity of available background data, DEQ will generally use a conservative estimate (e.g., maximum or 95th percentile) of background pollutant concentrations when assessing mixing zones.

Some criteria are dependent on other water quality chemical or physical parameters. For example, the ammonia criteria are dependent on temperature and pH. Criteria for seven metals (cadmium, chromium III, copper, lead, nickel, silver, and zinc) depend on water hardness. The hardness, pH, and temperature of water bodies will vary seasonally, and it is necessary to use conservative values for these parameters to ensure criteria are only rarely exceeded, after allowing for mixing. It may also be that critical temperatures, pH, or hardness do not correspond in time with critical low flows. This situation may call for a more sophisticated evaluation than simply using independently derived conservative values for each parameter. For example, the preferred approach may involve creating a time series of criteria values overlaying a time series of receiving streamflows to evaluate when assimilative capacity is at its minimum.

For more information on flows (accessed February 4, 2014):

- DFLOW
  http://epa.gov/waterscience/dflow/index.htm
- SWSTAT Instructions
  http://water.usgs.gov/software/swstat.html
- USGS Gage Information
  http://waterdata.usgs.gov/nwis/sw
- StreamStats (USGS)
  http://water.usgs.gov/osw/streamstats

As discussed in section 2.4.1, low-flow design discharge conditions for toxics criteria are specified in the WQS (IDAPA 58.01.02.210.03.b) and are based on the frequency component of the toxics criteria. Idaho WQS do not specify conservative estimates that should be used for hardness, pH, and temperature when evaluating the potential impact of a discharge on the receiving water body.

When evaluating mixing zones for criteria depending on hardness, pH, or temperature, DEQ believes that a conservative estimate of background concentrations of these three parameters should be used to calculate an applicable edge of mixing zone pollutant concentration in the following manner.

For effluent with greater or lower hardness, pH, or temperature than the receiving water body, use an estimate of the fully mixed conditions to calculate the applicable edge of mixing zone concentration. It has been general practice to use the 95th percentile of ambient pH and temperature data and the 5th percentile of ambient hardness data as conservative estimates of background concentrations to be used in the mixing zone evaluation. This approach is

appropriate for pH and temperature; however, it may not always be appropriate for hardness. The following section discusses methods that can be used to select a conservative value of background hardness.

For purposes of calculating criteria that are applicable at the edge of the mixing zone, the minimum hardness concentration for metals other than cadmium that may be used is 25 milligrams per liter (mg/L); the maximum is 400 mg/L. For cadmium, the minimum hardness concentration that may be used is 10 mg/L (IDAPA 58.01.02.210.03.c.i).

4.3.3.1 Background Hardness

If data are available, DEQ strongly suggests dischargers examine the relation between flow and hardness. DEQ plotted flow versus hardness data from 21 USGS gage sites and found most sites have an inverse relation between hardness and flow. Six examples are given in Figure 5. The relationship between hardness and flow can be nonexistent (Figure 5-a) to intermediate (Figure 5-d) to strong (Figure 5-c) and very strong (Figure 5-b).

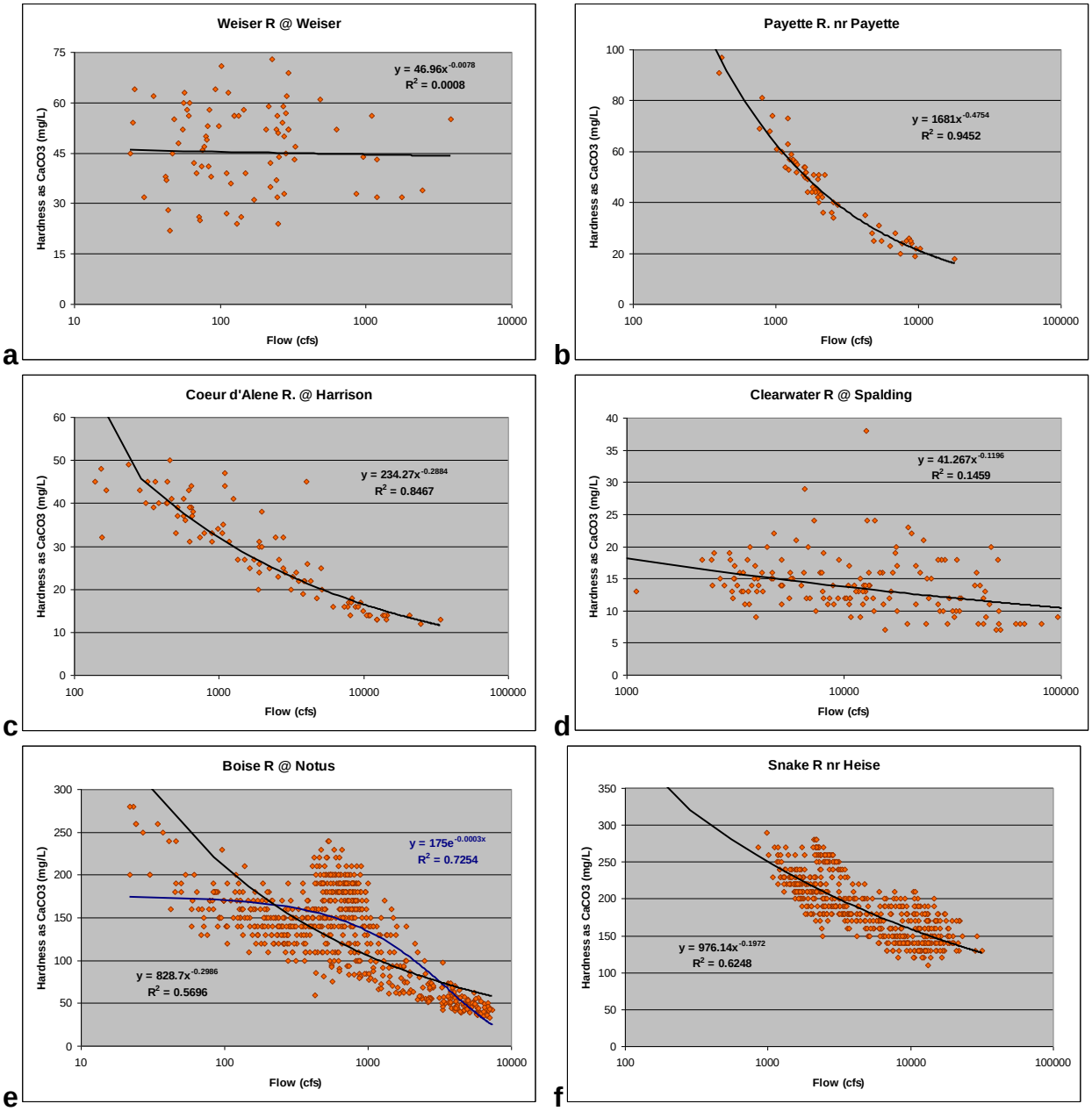

Figure 5. Example plots of water hardness versus flow.

An inverse relation between hardness and flow is problematic as it confounds conservative assumptions—low hardness and low flows do not co-occur. Taking a 5th percentile hardness value irrespective of flow and applying it at low flows could be overly conservative in many cases (e.g., Figure 5-b). If there is little relation between flow and hardness (Figure 5-a), then a 5th percentile of all hardness data will be representative of all flows, including low flows. But if an inverse relation exists, even if weak (Figure 5-d), then using all hardness data will not be representative of low-flow hardness.

Idaho WQS state the following:

> The hardness values used for calculating aquatic life criteria for metals at design discharge conditions shall be representative of the ambient hardness for receiving water that occur at the [low-flow] design discharge conditions given in Subsection 210.03.b. (IDAPA 58.01.02.210.03.c.ii.)

Thus, the hardness data must be representative of low flows. However, DEQ recognizes that availability of hardness data during low flows (or during a restricted range of flows that are representative of low flows) is typically limited. For example, using or obtaining hardness data only at 7Q10 flow is impracticable as this flow is a rare occurrence and is usually not known until after the fact. A wider window of flows is likely to provide more data, and more data will give better statistical estimates of hardness values such as the 5th percentile. Therefore, when there is a relation between hardness and flow, which will most often be the case, DEQ suggests that the maximum window of flows acceptable for getting hardness data representative of low design flow is the 3 months that typically have the lowest flows in a year. Narrower windows are better, especially if the relation between hardness and flow is steep (e.g., Figure 5-b). Data from a broader window of flows are acceptable but will likely result in an overly conservative estimate of low-flow hardness.

In many situations, the hardness versus flow relation may be unknown. DEQ suggests that 30 samples are adequate to plot a relation between hardness and flow and recommends a minimum of 12 samples during the low-flow period as a basis for estimating the 5th percentile or other low exceedance probability hardness value. The narrower the window of flows sampled and the higher the number of samples, the more likely the estimate of the 5th percentile hardness at design flow will be accurate and not overly protective.

If sufficient data are available, an alternative would be to use the statistical relation (nonlinear regression) between hardness and flow to estimate the hardness at the design flow. In this case, DEQ recommends at least 30 paired samples of flow and hardness over a range of flows and would use the lower 95th prediction limit on the regression estimate. Another option to approach the hardness versus flow relation and refine effluent limits accordingly is to employ flow-tiered effluent limits (see section 2.4.1).

4.3.4 Effluent Characteristics

Both effluent quantity and quality information are needed to evaluate mixing zones. For POTWs, the facility design flow is used in the mixing zone analysis. For other types of dischargers (e.g., industrial), the maximum recorded flow during the previous 5-year permit term is typically used; facilities anticipating expansion may choose to use projected design flows. An exception would be where facility changes have occurred such that the maximum flow is highly unlikely to be reached in the future (e.g., permanent shutdown of a portion of an industrial facility). In such cases, the maximum flow observed (or anticipated) under the current or planned future operating conditions would be used.

When characterizing the quality of the effluent, EPA follows the methodology described in the TSD (EPA 1991) to project the maximum possible effluent concentration from the maximum observed effluent concentration. For a new discharge, the pollutant concentration data may be obtained from the NPDES permit application. For a reissued permit, the maximum observed concentration is the highest level observed during the previous 5-year permit term. The

discharger should run the mixing zone model using the maximum projected effluent concentration. In addition, the discharger should run a series of mixing zone analyses using a variety of potential effluent limitations to assess the potential mixing zone sizes under different effluent conditions. The discharger should work with EPA and DEQ in obtaining a series of possible effluent limitations under different dilution scenarios.

4.3.5 Outfall and Diffuser Information

Required information for single-port discharges and multiport discharges (diffusers) includes the following:

1. Depth of the port(s) (or pipe depth and riser height)
2. Port diameters(s) and number of ports for multiport diffusers
3. Type of port mouth such as bell-mouthed or sharp-edged
4. Horizontal and vertical orientation of the port centerline for single-port discharge
5. Horizontal and vertical orientations and spacing of ports for multiport diffusers
6. Distance from shoreline to port or first and last port of a multiport diffuser
7. For side channel discharges, the channel's width, depth, bottom slope, and orientations
8. Photographs of the outfall structure or design plans for new discharges and
9. Photographs of the receiving stream

4.4 Dye Studies

Field dilution measurement using dye or other tracers can be useful in mixing zone analysis. Measuring tracer concentration in the mixing zone and the effluent discharge allows the direct determination of dilution under the specific conditions of the measurements. If the measurements are taken under critical conditions corresponding to a specified low ambient flow and maximum permitted effluent discharge and the dye or tracer has reached steady state concentration, the field results could be used as an alternative to modeling. In the event that conditions during the field study do not correspond to critical conditions, the results of the tracer or dye measurements can provide important data to validate a model. The use of preliminary modeling to design a dye or tracer study is highly recommended to ensure the use of adequate dye or tracer mass for detectable concentrations and the selection of spatial sampling locations. Chapter 4 of the EPA TSD (EPA 1991) provides a detailed discussion of dye studies.

5 Monitoring

DEQ may require monitoring of the outfall and the receiving water body as a condition of a §401 water quality certification to determine compliance with WQS when mixing zones have been authorized for a discharge. Such monitoring may include assessing the biological community (benthic macroinvertebrates or fish); physical conditions of the receiving water body; and concentrations of pollutants in sediment, water, and biota found in the receiving stream. Monitoring requirements will be determined on a case-by-case basis considering the pollutants of concern, low-flow design conditions, and the safety and practicality of sampling. The discharger should consult with DEQ when selecting the most appropriate sampling regiment.

A quality assurance project plan (QAPP) for the monitoring of authorized mixing zones will be required. The plan must detail the baseline conditions and the monitoring program. The QAPP must include information about sampling design, sampling methods, sample handling, analytical methods, data reporting, and quality assurance/quality control. More information on quality management can be found at: *http://www.deq.idaho.gov/assistance-resources/quality-management/* .

The sampling rigor required to characterize the potential impacts of a new or existing discharge will vary depending on the characteristics of the discharge and the receiving water body (i.e., a mixing zone for a toxic or bioaccumulative substance would require more monitoring than a substance with a low potential for toxic effects). Details of the physical, chemical, and biological monitoring and the level of sampling rigor required are summarized in the following sections.

5.1 Outfall Monitoring

The discharger should provide a description and construction or "as built" drawings of the outfall, including photographs of the discharge location. The description should include the size, shape, and configuration of the outfall structure/ports and details about construction materials. The discharger should periodically (at least once every 5 years) inspect the condition of the outfall and report its findings to DEQ. When an outfall exhibits significant differences in its physical condition from the plan or "as built" specifications, a re-evaluation of the mixing zone is required.

5.2 Physical/Chemical Monitoring

The discharger should periodically monitor the physical condition of the receiving water body in the vicinity of the discharge. When possible, stream cross-sections, ambient velocity, and water depth data should be collected near the outfall to validate the data inputs of the mixing zone model, if applicable.

To characterize background concentrations of pollutants expected in the discharge, the discharger should collect water quality samples at a monitoring station above the discharge. This sampling should occur during low-flow conditions when the discharge is expected to have the greatest impact. DEQ recommends a minimum of four consecutive day samples during low-flow conditions; however, a larger sample size is desirable to obtain a greater level of confidence in the background condition estimate. Single grab samples are sufficient at this phase of sampling (DEQ 2000).

In some cases, adequate background data may not be available. In these situations, a background concentration of zero in the mixing zone evaluation may be assumed and upstream monitoring required during the permit cycle to adequately characterize the background conditions of the receiving water for selected pollutants. These monitoring data will be used to evaluate the mixing zone during permit renewal.

When the discharge contains bioaccumulative substances, it is prudent to evaluate and/or monitor the sediments in the vicinity of a mixing zone. For instance, the potential for some pollutants (e.g., selenium) to bioaccumulate is related to the organic content (e.g., total organic

carbon) of the sediments. When required, sediments should be collected using methods such as those outlined by the USGS (Shelton and Capel 1994).

Where sediment is the pollutant of concern, turbidity monitoring should be considered. Monitoring should occur when project activities may result in turbidity increases above background levels. Monitoring requirements should specify a distance downstream from the in-water disturbance or point of discharge and within any visible plume. Results from the compliance point sampling must be compared to the background levels sampled during each monitoring event.

If the turbidity below any mixing zone exceeds background turbidity by 50 nephelometric turbidity units (NTU) or more for more than 10 consecutive days, the project is causing an exceedance of the WQS (IDAPA 58.01.02.250.02.e). Additionally, a discharge must not increase turbidity outside the mixing zone by more than 5 NTU over background when background turbidity is 50 NTU or less, or increase more than 10% when background turbidity is more than 50 NTU, not to exceed a maximum increase of 25 NTU (IDAPA 58.01.02.401.02).

For any authorized mixing zone or points of compliance, DEQ may require upstream/downstream monitoring to evaluate whether the discharge is resulting in a violation of WQS outside of the mixing zone.

5.3 Biological Monitoring

Bioassessments of instream biota (benthic macroinvertebrate, fish, and periphyton assemblages) are an important indicator to monitor for the protection of aquatic life beneficial uses. The recommended biological monitoring program for mixing zones outlined here is based on a well-established state-wide wadable stream and large river bioassessment program (Grafe 2002a, 2002b; DEQ 2016). Biological assemblages are valuable for monitoring because they integrate water quality impacts over longer periods of time compared to discrete water samples, which only reflect water quality conditions at the time of collection (Grafe 2002a, 2002b).

An appraisal of the biological conditions of the receiving water body may be required prior to authorizing a mixing zone or to evaluate the potential impacts of an approved mixing zone for an existing discharge. The level of effort and detail needed in such an evaluation will vary with the type of discharge, expected dilution, habitat type, potential for environmental impact, and other factors (see the discussion in section 5.4 for guidance on when to require more thorough monitoring).

For water bodies with long-term trend biomonitoring data available, baseline or upstream conditions can be estimated based on existing data, if the data quality meets Idaho standards (DEQ 2016). Where no previous data exist, or if the data are of insufficient quality, a mixing zone may be authorized and biological monitoring may be required. In developing biological sampling plans, the discharger should collaborate with DEQ and the EPA permit writer.

5.3.1 Periphyton Monitoring

Benthic algal assemblages, as attached primary producers, are affected by the physical, chemical, and biological conditions present during the period the assemblage developed. Diatoms are

particularly useful ecological indicators because they are found in abundance in most lotic systems, can be identified to species by experienced algologists, and are diverse enough to provide multiple indicators of various types of environmental disturbance. The EPA rapid bioassessment protocol (1999) provides a list of known generalized ecological tolerance values for many taxa, with extensive references for using periphyton as biological indicators. The protocol also includes methods for sampling, calculating, and interpreting periphyton assemblage data for bioassessment purposes. Idaho has two specific diatom indices: the river diatom index (RDI) developed by Fore and Grafe (2002) and the stream diatom index (SDI) developed by Cao et al. (2007). Details about the Idaho RDI, SDI, and the interpretation of diatom assemblage data can be found in Grafe (2002b), Cao et al. (2007), and Bahls (1993).

Primary producers are often very sensitive to pollutants in effluent discharges. Analyses of stressor-specific metrics for mixing zone constituents within the discharge, when possible, will be helpful for assessing the impacts of the mixing zone and establishing causation of any detected degradation. Changes in algal assemblages have been shown to result from metals stress, increased salinity, excess nutrients, decreased dissolved oxygen, changes in pH, and sediment load (DEQ 2000; LaPoint and Waller 2000; Fore and Grafe 2002). The RDI and other applicable diatom metrics and indexes may be used to supplement the invertebrate and fish community assessments that are routinely done in Idaho stream bioassessments, since each assemblage will provide added and unique information on the mechanisms of degradation (EPA 1999).

The periphyton assemblage should be sampled at least once annually. For systems with no or few periphyton data, increased sampling frequency should be considered. Periphyton assemblage sampling should follow the methods used by Fore and Grafe (2002). Baseline periphyton assemblage characteristics should be sampled upstream, within (if practicable), and downstream from the proposed (or existing) mixing zone.

When monitoring for a new discharge, the timing of postdischarge sampling should be similar to the predischarge sampling regime and should begin the first year of discharge. The discharger should show that pre- and postdischarge (or upstream and downstream) conditions are similar and that the discharge is not causing unreasonable interference with the beneficial uses. DEQ may reduce the monitoring requirements if sufficient documentation shows the discharge is not resulting in unreasonable interference with the beneficial uses.

5.3.2 Macroinvertebrate Monitoring

Benthic macroinvertebrates have become the most commonly sampled assemblage for bioassessment programs (EPA 1999). Macroinvertebrates are excellent ecological indicators because (1) indigenous benthic macroinvertebrates are ecologically important as an intermediate trophic level between microorganisms and fish; (2) they are abundant in most streams; (3) they have either limited migration patterns or are sessile, making them suitable for detecting site-specific impacts; and (4) their life spans are of several months to a few years, allowing them to integrate the impacts of sediment and water quality over time (DEQ 2000).

Impacts to the macroinvertebrate assemblage can have large ramifications for other aquatic assemblages because they are an essential component for energy cycling in aquatic ecosystems and are the primary food source for fish, including salmonids and sculpins. Idaho has a long

history of using benthic macroinvertebrates in the biological assessment of the state's streams and rivers. Idaho has developed a regionally calibrated multimetric index using benthic macroinvertebrates (Grafe 2002a, 2002b; Jessup and Gerritsen 2002). The sampling methods, laboratory processing, metric selection, data analyses, data interpretation, and QA/QC used in mixing zone monitoring programs should generally comply with these state methodologies.

Macroinvertebrate communities are sensitive indicators of many diverse environmental impacts, including excess nutrients, riparian disturbance, thermal alterations, low dissolved oxygen, pH, sedimentation, and many other stressors (EPA 1999; Yuan and Norton 2003). Furthermore, macroinvertebrate communities have been reliable indicators of metals pollution (DEQ 2000) and for specific metals such as copper and zinc (Winner et al. 1980; Clements and Kiffney 1994; Carlisle and Clements 1999; Richardson and Kiffney 2000; Mebane 2001).

Sampling for macroinvertebrates should be conducted at least once annually and at the same time and within the same sites as the periphyton assemblage. For systems with species of special concern or otherwise requiring additional scrutiny, biannual sampling should be considered. Water body size (see Grafe 2002a, 2002b) should be considered when selecting a sampling protocol. Baseline benthic macroinvertebrate assemblage characteristics should be sampled upstream, within, and downstream from the proposed (or existing) mixing zone.

When monitoring for a new discharge, postdischarge sampling of benthic macroinvertebrates should be conducted during the same period(s) and at the same locations as the predischarge sampling regime. The discharger should demonstrate that pre- and postdischarge conditions (or upstream and downstream conditions) are similar and that the discharge is not causing unreasonable interference with beneficial uses of the receiving water body. DEQ may reduce the monitoring requirements if sufficient documentation shows that the discharge is not resulting in unreasonable interference with the beneficial uses.

5.3.3 Fish Monitoring

Fish are also excellent biological indicators of stress because they integrate impacts from stressors over long time periods and great distances, and fish community structure and function are often related, either directly or indirectly, to a variety of stressors. Typical stressors reflected in fish assemblage degradation include temperature changes, decreased dissolved oxygen, sedimentation, pH changes, ionic concentration and salinity, reduced habitat structure, flow rates, metals, and a variety of toxins (EPA 1999; Grafe 2002a, 2002b).

Unlike periphyton and benthic macroinvertebrates, fish are mobile and do not solely reflect conditions at their location of capture. DEQ recognizes that factors aside from the discharge could adversely affect fish population trends, such as habitat degradation within the watershed, increasing stream temperatures, or competition from other species. Furthermore, fish assemblages are often directly managed and harvested by humans, so interpretations of assemblage alterations should include some information on stocking and harvest in the water body. For these reasons, greater caution should be used when evaluating fish monitoring data, and DEQ will generally place more weight on monitoring resident aquatic life such as benthic macroinvertebrates or periphyton.

DEQ uses fish monitoring data to determine use attainment during bioassessments of all stream classes (Grafe 2002a, 2002b). Idaho has developed three regionally calibrated fish indices of biological integrity for its streams. For coldwater streams, a stream fish index was created specifically for Idaho's forested ecoregion and Idaho's rangeland ecoregion (Grafe 2002a). For Idaho's large river basins, the river fish index was developed (Grafe 2002b). Detailed information on site selection, fish sampling, identification, and data analysis and interpretation can be found in chapter 3 of the Beneficial Use Reconnaissance Program manual (DEQ 2015), chapter 4 of Grafe 2002a, or chapter 4 of Grafe 2002b.

Sampling for fish should be conducted within the same area as the other two biological assemblages. However, given the mobility and size of fish, it is more reasonable to sample long reaches (minimum of 100 meters) above and below the discharge, rather than at multiple smaller sites. See DEQ 2015 for guidance on reach selection and method. Sampling should be conducted at least once following the methods described in Grafe 2002a and 2002b, depending on the water body size. Fish assemblage characteristics should be sampled from a minimum of one reach upstream and one reach downstream from the proposed (or existing) mixing zone.

For new discharges, the postdischarge sampling of fish should be similar to the predischarge sampling regime. Fish assemblages should be monitored annually for a minimum of 2 years. Sampling for the life of the permit is preferable and should be considered. The discharger must show that pre- and postdischarge conditions (or upstream and downstream conditions) are similar and that the discharge is not causing unreasonable interference with the beneficial uses. DEQ may reduce the monitoring requirements if sufficient documentation shows the discharge is not resulting in unreasonable interference with the beneficial uses.

5.4 Determining Appropriate Level of Monitoring

Not all discharges and authorized mixing zones are identical, so some flexibility must be available when determining the appropriate level of monitoring. The critical factors to determine the appropriate magnitude of monitoring have been identified and are discussed below (Table 4).

Generally, DEQ will require little, if any, monitoring for facilities where a level 1 or 2 mixing zone analysis is appropriate, unless background pollutant concentrations are not adequately characterized. As the level of mixing zone analysis increases, the likelihood of chemical, physical, or biological ambient monitoring will increase; best professional judgment must be used in determining the appropriate level of monitoring required for any mixing zone.

Table 4. Summary of factors to consider in developing monitoring programs.

Factor	May Require More Monitoring	May Require Less Monitoring
Size	Comparatively large mixing zone	Small mixing zone (e.g., use of a diffuser in a large water body)
Constituents of concern	Mixing zone for multiple pollutants (e.g., several metals) that may present additional risk (e.g., potential additive and/or synergistic effects)	Few or only one constituent of concern
Presence of bioaccumulative pollutants	Mixing zone applicable to bioaccumulative substances (e.g., mercury)	Mixing zone applicable to nonbioaccumulative pollutants
Species of concern	Species of concern occurring in the vicinity of the mixing zone	Species of concern unlikely to occur in the vicinity of the mixing zone
Critical habitat/migratory route	Mixing zone in an area of concern (e.g., critical habitat, salmonid spawning habitat, or migration route for salmon or steelhead)	Mixing zone area is not considered critical habitat or a migration corridor and does not provide salmonid spawning habitat
Existing monitoring data	New discharge	Existing discharge where comprehensive, current data suggest the existing mixing zone has not had negative impacts and its continued existence is unlikely to have negative impacts

5.4.1 Mixing Zone Size

The extent of the mixing zone should be taken into account when determining whether monitoring is required. Mixing zones where the plume is expected to mix rapidly and take up a relatively small portion of receiving water body habitat in the vicinity of the discharge should be of less concern than larger mixing zones where the plume mixes more slowly and the mixing zone occupies a larger portion of the available habitat. A larger mixing zone exposes a greater area of the receiving water body and resident biota to water quality conditions that do not meet water quality criteria. Thus, the larger the mixing zone, the greater potential for negative impacts to the receiving water body and the greater the need for increased monitoring.

5.4.2 Number of Constituents of Concern

Mixing zones may be established for complex effluents that contain a number of different parameters (e.g., treated mine effluent) or for relatively simple effluents that contain a single constituent of concern (e.g., temperature in cooling water discharge). The level of uncertainty regarding potential impacts increases with the number of constituents for which a mixing zone has been established. Thus, the number of constituents should be considered in determining the potential level of impact and requisite monitoring.

5.4.3 Presence of Bioaccumulative Pollutants

Mixing zones for bioaccumulative pollutants are of concern because impacts related to bioaccumulation in aquatic organisms are often delayed, manifest more clearly in the biota than in the water column, occur over long periods (e.g. human health criteria are based on 70 years of exposure) and can exceed levels protective of human health or aquatic life. Establishing a mixing

zone for bioaccumulative pollutants may trigger monitoring for a sufficient time period necessary to determine whether bioaccumulation in the food chain is a concern. This time period will be determined on a case-by-case basis and may be defined as the life of the permit. Factors to consider when determining how long the monitoring should occur may include the bioconcentration factor, concentration in the discharge, and the expected concentration in the mixing zone.

5.4.4 Species of Special Concern

A mixing zone may require more monitoring if species of special concern occur in the vicinity of the mixing zone. For more information about species of special concern, see section 2.2.6.

5.4.5 Migratory Route and Critical Habitat

Salmonid migration can be interrupted by elevated concentrations of pollutants known to elicit avoidance responses. Therefore, mixing zones on migratory routes of salmonids must be evaluated. Additional monitoring of salmonid passage may be required if such a mixing zone contains pollutants known to elicit avoidance behavior and the mixing zone is relatively large. Mixing zones through critical habitat (especially for species of special concern) may also need additional evaluation.

5.4.6 Availability of Existing Monitoring Data

If existing high-quality monitoring data are available at the time of permit renewal, such data should be reviewed and used to determine whether or not the existing mixing zone has the potential to degrade the resource. Monitoring data may be used to justify an increase (if impacts have been observed) or decrease (if no impacts have been observed) in the level of required monitoring. Where impacts are observed, the data should be used to adjust the mixing zone authorization as necessary to diminish future impacts.

5.5 Interpretation and Follow-up

The discharger is responsible for collecting, evaluating, and reporting the results of the monitoring data. The results of the physical, chemical, and biological assessment of the mixing zone's impacts to the water body must be analyzed collectively so that differences in upstream and downstream parameters (e.g., chemical constituent, biological metric or index of biological integrity, physical habitat trait) can be attributed to the correct cause. The discharger may work collaboratively with DEQ in evaluating the data and reporting the results.

DEQ will review the report and determine the adequacy of the data and appropriateness of the conclusions. If the discharger concludes, and DEQ concurs, that the mixing zone is the most likely source of alterations in downstream conditions, then the regulatory agencies will take appropriate actions to revise the authorized mixing zone and monitoring requirements to ensure that beneficial uses are not degraded. On the other hand, if a discharger concludes, and DEQ concurs, that the discharge is not adversely impacting the beneficial uses of the receiving water body, then DEQ may lessen the monitoring requirements in subsequent permits. The potential scenarios that could occur during these analyses are many. An example from a mixing zone analysis can be found at *www.deq.idaho.gov/media/450859-thompson_creek_mixing_zone_report.pdf*.

6 Glossary

Beneficial Use. Any of the various uses which may be made of the water of Idaho, including, but not limited to, aquatic life, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics. The beneficial use is dependent on actual use, the ability of the water to support a nonexisting use either now or in the future, and its likelihood of being used in a given manner.

Bioaccumulation. The process by which a compound is taken up by, and accumulated in the tissues of an aquatic organism from the environment, both from water and through food).

Bioaccumulation Factor (BAF). The ratio of a substance's concentration in tissue versus its concentration in ambient water in situations where the organisms and the food chain are exposed.

Bioconcentration. The process by which a substance is absorbed from water through gills or epithelial tissue and is concentrated in the body.

Bioconcentration Factor (BCF). The ratio of a substance's concentration in tissue versus its concentration in ambient water in situations where the food chain is not exposed or contaminated.

Buoyancy. As it relates to mixing zone analyses, buoyancy refers to the upward force of the effluent plume in the receiving water due to density differences.

Criterion Continuous Concentration (CCC). The 4-day average concentration of a toxic substance or effluent that ensures adequate protection of sensitive species of aquatic organisms from chronic toxicity resulting from exposure to the toxic substance or effluent.

Criterion Maximum Concentration (CMC). The maximum instantaneous or 1-hour average concentration of a toxic substance or effluent which ensures adequate protection of sensitive species of aquatic organisms from acute toxicity due to exposure to the toxic substance or effluent.

Designated Beneficial Use or Designated Use. Those beneficial uses assigned to identified waters in the Idaho DEQ rules, "Water Quality Standards" (IDAPA 58.01.02.110 through 02.160), whether or not the uses are being attained.

Dilution Factor. A measure of the amount of mixing of the effluent and receiving water at the edge of the mixing zone.

Discharge Length Scale. The square root of the cross-sectional areas of any discharge pipe at its outlet. If the discharge is a multiport diffuser, then the discharge length scale should be calculated for each port.

Effluent-Dominated Water. Waters where the volume of effluent flow is greater than the volume of streamflow.

Effluent Limitation. The highest amount of pollutant concentration or mass that can be discharged from a point source into waters of the US. Effluent limitations can be expressed as

single measurements (instantaneous or daily maximums) or as averages over a given period of time (daily, weekly, or monthly averages).

Essential Fish Habitat (EFH). Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate. "Substrate" includes sediment, hard-bottom structures underlying the waters, and associated biological communities. "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. "Spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

EFH has been designated for the 83 species of Pacific Coast groundfish, 3 species of salmon, and 5 species of coastal pelagic fish and squid that are managed by the Pacific Fishery Management Council. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires federal agencies to consult with National Oceanic and Atmospheric Administration on actions that may adversely affect EFH.

Existing Beneficial Use or Existing Use. Those beneficial uses actually attained in waters on or after November 28, 1975, whether or not they are designated for those waters in Idaho DEQ rules, IDAPA 58.01.02, water quality standards.

Far-Field Mixing. Mixing that occurs beyond the near-field area and is controlled by passive diffusion and ambient turbulence.

Harmonic Mean Flow. The number of daily measurements divided by the sum of the reciprocals of the measurements, in this case flow (i.e., the reciprocal of the mean of reciprocals).

Index of Biological Integrity. A synthesis of diverse biological information that numerically depicts associations between human influence and biological attributes. It is composed of several biological attributes or "metrics" that are sensitive to changes in biological integrity caused by human activities. The multimetric (a compilation of metrics) approach compares what is found at a monitoring site to what is expected using a regional baseline condition that reflects little or no human impact.

Inhibition Concentration (IC). The point estimate of the toxic concentration that would cause a given percent reduction in a nonlethal biological measurement (e.g., reproduction or growth). IC25 is a point estimate of the toxic concentration that would cause a 25% reduction in a biological measurement of a test organism.

Jet Momentum. As it relates to mixing zone analyses, jet momentum refers to the initial momentum flux caused by high velocity injection of effluent into the receiving water.

Lethal Concentration. The point estimate of an effluent concentration that would be lethal to a given percentage of test organisms during a specified period. For example, the lethal concentration 50 (LC_{50}) is the concentration of effluent at which 50% of test organisms die.

Lowest Observed Effects Concentration (LOEC). The lowest concentration of a toxic substance or that results in observable adverse effects in the aquatic test population.

Mixing Zone. A defined area or volume of the receiving water surrounding or adjacent to a wastewater discharge where the receiving water, as a result of the discharge, may not meet all applicable water quality criteria or standards. It is considered a place where wastewater mixes with receiving water and not a place where effluents are treated.

Near-Field Mixing. The immediate area around the discharge point where mixing occurs due to the velocity/momentum of the discharge.

Nephelometric Turbidity Unit (NTU). A measure of turbidity based on a comparison of the intensity of the light scattered by a sample under defined conditions with the intensity of the light scattered by a standard reference suspension under the same conditions.

No Observed Effect Concentration (NOEC). The highest tested concentration of an effluent at which no adverse effects are observed on the aquatic test organisms at a specific time of observation.

1Q10. The lowest one-day flow with an average recurrence frequency of once in ten (10) years, determined hydrologically.

Plume. The physical area within the water body where the effluent mixes with the receiving water and there is a distinguishable difference from the ambient water conditions.

Primary Contact Recreation. Prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving.

Public Swimming Beach. Areas indicated by features such as signs, swimming docks, diving boards, slides, or the like, boater exclusion zones, map legends, collection of a fee for beach use, or any other unambiguous invitation to public swimming. Privately owned swimming docks or the like which are not open to the general public are not included in this definition.

Reasonable Potential Analysis (RPA). The analysis conducted by the permitting authority to determine whether a discharge has “reasonable potential” to cause an exceedance above applicable water quality criteria. The analysis must consider all of the factors listed in 40 CFR 122.44(d)(1)(ii).

Reasonable Potential to Exceed (RPTE). Refers to the reasonable potential for a pollutant to exceed water quality standards and may be determined as the result of a reasonable potential analysis.

Reference Dose (RfD). An estimate of the daily exposure of a substance to human population that is likely to be without appreciable risk of deleterious effect during a lifetime.

Secondary Contact Recreation. Recreational uses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur.

7Q10. The lowest average seven (7) consecutive day low flow with an average reoccurrence frequency of once in ten (10) years determined hydrologically.

Species of Special Concern. Native species that are either low or declining in numbers, limited in distribution, or have suffered significant habitat losses, identified by the Idaho Department of Fish and Game.

Toxic Unit - Acute (TU_a). The reciprocal of the effluent concentration that causes 50% of organisms to die by the end of the acute exposure period.

Toxic Unit - Chronic (TU_c). The reciprocal of the effluent concentration that causes no observable effect on the test organisms by the end of the chronic exposure period. Additional chronic endpoints may be the lowest observable effect or the inhibition concentration.

Toxic Unit - (TU). A measure of toxicity in an effluent as determined by the acute toxic units or chronic toxic units measured.

Water Column. A hypothetical cylinder of water from the surface of a water body to the bottom, within which physical and chemical properties can be measured.

Water Quality-Based Effluent Limitations (WQBELs). An effluent limitation determined by selecting the most stringent of the effluent limits calculated using all applicable water quality criteria (e.g., aquatic life, human health, wildlife, translation of narrative criteria) for a specific point source to a specific receiving water.

Water Quality Standards. Regulations consisting of designated uses, criteria to protect those uses, an antidegradation policy, and various optional elements (e.g., a mixing zone policy and variance policy) geared toward protecting the quality of waters of the US. Idaho's water quality standards are codified in IDAPA 58.01.02.

Wetted Width. The width of a water surface (at a specific discharge) measured perpendicular to the direction of flow.

Whole Effluent Toxicity (WET). The aggregate toxic effect of an effluent measured directly with a toxicity test.

Zone of Initial Dilution (ZID). An area within a Department authorized mixing zone where acute criteria may be exceeded. This area shall be no larger than necessary and shall be sized to prevent lethality to swimming or drifting organisms by ensuring that organisms are not exposed to concentrations exceeding acute criteria for more than one (1) hour more than once in three (3) years. The actual size of the ZID will be determined by the Department for a discharge on a case-by-case basis, taking into consideration mixing zone modeling and associated size recommendations and any other pertinent chemical, physical, and biological data available.

7 References

Bahls, L.L. 1993. *Periphyton Bioassessment Methods for Montana Streams*. Helena, MT: Montana Water Quality Bureau, Department of Health and Environmental Science.

Batt, P. 1996. *State of Idaho Bull Trout Conservation Plan*. Boise, ID: Office of the Governor.

Baumgartner, D.J., W.E. Frick, and P.J.W. Roberts. 1994. *Dilution Models for Effluent Discharges*, 4th ed. Washington, DC: US Environmental Protection Agency. EPA Report #600/R-03/025.

Cao, Y., C. Hawkins, J. Olson, and M.A. Kosterman. 2007. "Modeling Natural Environmental Gradients Improves the Accuracy and Precision of Diatom-Based Indicators." *Journal of the North American Benthological Society* 26(3):566–585.

Carlisle, D.M. and W.H. Clements. 1999. "Sensitivity and Variability of Metrics Used in Biological Assessment of Running Waters." *Environmental Toxicology and Chemistry* 18:285–291.

CFR (Code of Federal Regulations). 1983. EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.40 CFR 122.44(d)(1)(ii).

CFR (Code of Federal Regulations). "Standards for Protection Against Radiation." 10 CFR 20. Appendix B.

Clements, W.H. and P.M. Kiffney. 1994. "Integrated Laboratory and Field Approach for Assessing Heavy Metals at the Arkansas River, Colorado." *Environmental Toxicology and Chemistry* 13:387–404.

Davis, L.R. 1999. *Fundamentals of Environmental Discharge Modeling*. Boca Raton, FL: CRC Press.

DEQ (Idaho Department of Environmental Quality). 2015. *Beneficial Use Reconnaissance Program Field Manual for Streams*. Boise, ID: DEQ.

———. 2000. *Evaluation of Proposed New Point Source Discharges to a Special Resource Water and Mixing Zone Determinations: Thompson Creek Mine Facility, Upper Salmon River Subbasin, Idaho.* Boise, ID: DEQ. NPDES Permit Application ID-002540-2.

———. 2016. *Water Body Assessment Guidance, 3rd Edition.* Boise, ID: DEQ.

EPA (US Environmental Protection Agency). 1991. *Technical Support Document for Water Quality-based Toxics Control*. EPA/505/2-90-001, Washington, DC. Available at *http://www.epa.gov/npdes/pubs/owm0264.pdf*. Accessed July 13, 2009.

———. 2014. *Water Quality Standards Handbook*, 2nd ed. Washington, DC: EPA. EPA/820/B-14/008. Available at http://www.epa.gov/wqs-tech/water-quality-standards-handbook-chapters.

———. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*, 2nd ed. Washington, DC: EPA. EPA 841-B-99-002. *www.epa.gov/owowwtr1/monitoring/rbp/index*.

———. 2002a. *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters for Freshwater Organisms*, 4th ed. Washington, DC: EPA. EPA-821-R-02-013.

———. 2002b. *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms*, 5th ed. Washington, DC: EPA, Office of Water. EPA-821-R-02-012.

———. 2003. *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards*. Seattle, WA: EPA, Region 10 Office of Water. EPA 910-B-03-002.

Federal Register. 2005. "Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs" Federal Register 70(123):37160-37204. Available at *www.nmfs.noaa.gov/pr/pdfs/fr/fr70-37160.pdf*.

———. 1999. 64 (209): 58666-58753. Available at *www.gpo.gov/fdsys/pkg/FR-1999-10-29/pdf/99-28169.pdf*.

Fore, L. and C.S. Grafe. 2002. "Chapter 5: River Diatom Index." In *Idaho River Ecological Assessment Framework: An Integrated Approach*, edited by C.S. Grafe. Boise, ID: Idaho Department of Environmental Quality.

Frick, W.E., P.J.W. Roberts, L.R. Davis, J. Keyes, D.J. Baumgartner, and K.P. George. 2003. *Dilution Models for Effluent Discharges*. EPA/600/R-03/025.

Grafe, C.S., editor. 2002a. *Idaho Small Stream Ecological Assessment Framework: An Integrated Approach*. Boise, ID: Idaho Department of Environmental Quality.

———. 2002b. *Idaho River Ecological Assessment Framework: An Integrated Approach*. Boise, ID: Idaho Department of Environmental Quality.

IDAPA 2015. "Water Quality Standards." Idaho Administrative Code. IDAPA 58.01.02.

IDFG (Idaho Department of Fish and Game). 2005. *Idaho Comprehensive Wildlife Conservation Strategy*. Boise, ID: IDFG, Idaho Conservation Data Center. Available at *http://fishandgame.idaho.gov/public/wildlife/cwcs/*.

IDFG (Idaho Department of Fish and Game). 2013. *Fisheries Management Plan 2013–2018*. Boise, ID: IDFG, Idaho Conservation Data Center. Available at *http://fishandgame.idaho.gov/public/fish/planFisheries.pdf*.

Jessup, B.K. and J. Gerritsen. 2002. *Development of a Multimetric Index for Biological Assessment of Idaho Streams using Benthic Macroinvertebrates*. Submitted by Tetra Tech, Inc. to the Idaho Department of Environmental Quality.

Jirka, G.H., R.L. Doneker, and S.W. Hinton. 1996. *User's Manual for CORMIX: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters*. Washington, DC: US Environmental Protection Agency, Office of Science and Technology.

LaPoint, T.W. and W.T. Waller. 2000. "Field Assessments in Conjunction with Whole Effluent Toxicity Testing." *Environmental Toxicology and Chemistry* 19:14–24.

Lysne, S. 2009. *A Guide to Southern Idaho's Freshwater Mollusks.* US Fish and Wildlife Service, US Bureau of Reclamation, USDA Forest Service, Idaho's Governor's Office of Species Conservation, the College of Idaho, Orma J. Smith Museum of Natural History. Available at *www.fws.gov/idaho/home/snailguidefinal92009topkg.pdf.*

Mebane, C.A. 2001. "Testing Bioassessment Metrics: Macroinvertebrate, Sculpin, and Salmonid Responses to stream Habitat, Sediment, and Metals." *Environmental Monitoring and Assessment* 67(3):293–322.

Muellenhoff, W.P., A.M. Soldate, D.J. Baumgartner, M.D. Schuldt, L.R. Davis, and W.E. Frick. 1985. *Initial Mixing Characteristics of Municipal Ocean Outfall Discharges, Vol. 1: Procedures and Applications*. Washington, DC: EPA. EPA/600/3-85/073a.

Richardson, J. S. and P. M. Kiffney. 2000. "Responses of a Macroinvertebrate Community from a Pristine, Southern British Columbia, Canada, Stream to Metals in Experimental Mesocosms." *Environmental Toxicology and Chemistry* 19:736–743.

Shelton, L.R. and P.D. Capel. 1994. *Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water-Quality Assessment Program*. Sacramento, CA: US Geological Survey. Open-File Report 94-458. Available at: *http://water.usgs.gov/nawqa/pnsp/pubs/ofr94-458*.

Winner, R.W., M.W. Boesel, and M.P. Farrell. 1980. "Insect Community Structure as an Index of Heavy-Metal Pollution in Lotic Ecosystems." *Canadian Journal of Fisheries and Aquatic Science* 37:647–655.

Yuan, L.L. and S.B. Norton. 2003. "Comparing Responses of Macroinvertebrate Metrics to Increasing Stress." *Journal of the North American Benthological Society* 22:308–322.

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Appendix A. Cross-Reference of IDAPA Mixing Zone Rules and Manual Sections

IDAPA Section	Regulatory Requirement	Mixing Zone Manual Section
58.01.02.010.61	Defines a mixing zone	1.1
58.01.02.051	Includes the State's antidegradation policy	2.1
58.01.02.060.01	Establishes that DEQ may authorize a mixing zone on a case-by-case basis when a permit is issued, renewed, or materially modified	Throughout the document, specifically 2
58.01.02.060.01.a	Indicates when a pollutant in a receiving water does not meet water quality criteria but may receive a mixing zone	2.7.1
58.01.02.060.01.b	Allows water quality exceedance of chronic water quality criteria within zone of initial dilution	Throughout the document, specifically 2
58.01.02.060.01.c	Indicates a mixing zone is evaluated on permitted design flow and must not be larger than necessary	2.4
58.01.02.060.01.d	Establishes mixing zones must not cause unreasonable interference with or danger to beneficial uses	2
58.01.02.060.01.e.i	Allows multiple nested mixing zones for a single point of discharge	2.4.3
58.01.02.060.01.f	Establishes multiple mixing zones for a single activity with multiple points of discharge	2.4.3
58.01.02.060.01.g	Indicates adjacent mixing zones from independent activities shall not overlap	2.4.3
58.01.02.060.01.h.i	Indicates that the width of a mixing zone in flowing waters should not exceed 25% of the stream width or 25% of low-flow design discharge conditions	2.4.1
58.01.02.060.01.h.ii	Indicates requirements for new discharges to nonflowing waters	2.4.2
58.01.02.060.01.h.iii	Indicates requirement for existing discharges to nonflowing waters	2.4.2
58.01.02.060.01.h.iv	Defines which lakes and reservoirs are considered nonflowing waters	2.4.2
58.01.02.060.01.i	Describes when a mixing zone may vary from subsection 060.01.h	2.6
58.01.02.060.01.j	Indicates outfall design criteria	2.4.1.3
58.01.02.060.02	Establishes points of compliance as alternatives to mixing zones	2.7.3
58.01.02.210.01	Includes criteria for toxic substances for aquatic life, recreation, and domestic water supply uses	2.1, 2.2, and 2.3
58.01.02.210.03.a	Indicates that criteria apply at the appropriate locations specified within or at the mixing zone boundary	1.2

IDAPA Section	Regulatory Requirement	Mixing Zone Manual Section
58.01.02.210.03.b	Defines the flow values (e.g., 7Q10 and harmonic mean flow) to be used in mixing zone analyses based on the designated use and type of criteria	2.4.1; Table 3
58.01.02.250	Includes aquatic life criteria for other pollutants, including ammonia, pH, temperature, dissolved oxygen, turbidity, and dissolved gas	2.1 and 2.2
58.01.02.251.01	Defines the bacteria criteria that apply for protection of recreation uses	2.3.2
58.01.02.401.01 through 401.03	Includes criteria for temperature, turbidity, and chlorine that apply to wastewater discharges	2.1

Appendix B. Mixing Zone Data Needs Form

Mixing Zone Data Needs Form

The following information should be gathered, as appropriate, when conducting a mixing zone analysis. To determine what is appropriate, please see the document detailing the level of analysis and data inputs (Appendix C of the *Idaho Mixing Zone Implementation Guidance*). DEQ staff will work with the applicant to ensure compliance with the requirements of IDAPA 58.01.02.060. DEQ may request additional information from the applicant if necessary. Discharges without authorized mixing zones must meet state water quality standards at the point of discharge.

GENERAL INFORMATION

1. Applicant Information					
First Name:		Last Name:			
Title:					
Street Address:					
City:		State:		Zip:	
Phone #:		Fax #:			
E-mail:					

1a. Authorized Agent Information (if applicable)					
First Name:		Last Name:			
Title:					
Street Address:					
City:		State:		Zip:	
Phone #:		Fax #:			
E-mail:					

2. Facility Information					
Name:					
Street Address:					
City:		State:		Zip:	
Phone #:		Fax #:			

MIXING ZONE INFORMATION

3. Level of Analysis Reflected in this Request:
☐ Level 1 ☐ Level 2 ☐ Level 3
4. List of pollutants for which a mixing zone may be required:
5. Map: *Attach a topographic map showing location of the discharge(s), other NPDES discharges, drinking water intakes, spawning habitat, and recreation access to the water body (e.g., boat ramps, public swimming beaches).*
6. Photos: *Attach at least one photo illustrating the location of the outfall and its relationship to the receiving water body*

7. Effluent Information			
Flow rate (cfs):		Velocity (ft/s):	
Pollutant Concentrations: *Attach a list of pollutant concentrations expected/measured in outfall*			

8. Outfall Information			
Latitude/Longitude of Outfall(s) in **either** *decimal degrees* **or** *degrees, minutes, seconds*			
Latitude:		Longitude:	
Lat/Long Coordinate Source: ☐ Internet ☐ Map ☐ GPS/Survey* *Identify DATUM used:			
Nearest bank is on the left or right (as facing downstream):			

Distance from shoreline to single port or first port on diffuser (m):	
Height of port(s) above stream bottom (m):	
Diameter of port(s) (m):	
Horizontal angle of port centerline (σ):	
Vertical angle of port centerline (θ):	
Multiport Diffuser? ☐ YES ☐ NO *If yes, answer questions below, as appropriate.*	
Length of diffuser (m):	
Distance from shoreline to last port on diffuser (m):	
Number of ports:	
Distance between ports (m):	
Number of ports per riser:	
Orientation of ports along diffuser line (same direction or fanned out):	
Angle between diffuser line and ambient current (γ):	
Angle between port centerline projection and diffuser axis (β):	
Other Outfall Design Information:	

9. Receiving Water Body Information			
Stream Name:		HUC (8-digit):	
Beneficial Uses (check all that apply):			
Aquatic Life*: ☐ COLD ☐ WARM ☐ SC ☐ MOD ☐ SS ☐ NONE			
* COLD = cold water; WARM = warm water; SC = seasonal cold; MOD = modified; SS = salmonid spawning; NONE = Use Unattainable			

Contact Recreation: ☐ Primary ☐ Secondary Water Supply: ☐ Domestic
Is there a public swimming beach near the discharge? ☐ YES ☐ NO If yes, distance from the outfall (m): ☐ upstream ☐ downstream
Is there a surface drinking water intake near the discharge? ☐ YES ☐ NO If yes, distance from the outfall (m): ☐ upstream ☐ downstream
List any pollutants for with the receiving water body is impaired.

Low-Flow Design Discharge Conditions (cfs)	7Q10:		1Q10:		*Other*:	
			Harmonic mean:			
Low Flow source:						
Channel depth (ft):		Channel width (ft):				

Pollutant concentrations: *Attach a list of background pollutant concentrations, if available. Include the source of information.*
Describe any available biological data *(attach additional sheets if needed):*

10. Existing Mixing Zone Size & Configuration *(if known)* **of Each Pollutant** *(attach additional information if multiple mixing zones were previously authorized)*							
% of flow:		Dilution factor:		Width (m):		Length (m):	
Is this a shore-hugging plume? ☐ YES ☐ NO							

11. Model/ Dye Study Information (Levels 2 and 3)
On an attached sheet, describe the input values not included on this form, the assumptions, and the outcome of the model used. Attach a copy of the dye study, if one was conducted.

12. DATA GATHERED BY:			
Applicant Representative Name(s):		Date:	
DEQ Staff Name(s):			

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How to Complete the Mixing Zone Data Needs Form

Instructions by Item

1. Provide applicant's complete name, mailing address, phone number, fax number, and e-mail address if available.

1a. If the applicant wishes to designate an agent to represent him during the permit process, provide agent's name and complete mailing address.

2. Provide the facility name, address, phone number, and fax number.

3. Indicate the level of analysis (see section 3.4 of the *Idaho Mixing Zone Implementation Guidance*) that is reflected in the request form.

4. List the pollutants for which a mixing zone is being requested.

5. Include a map of the discharge with the information specified in the request form.

6. Provide at least one photo showing the outfall location and its relationship to the receiving water body.

7. Provide the effluent flow rate and expected velocity. List the pollutants (and their expected/measured concentrations) expected to be in the discharge.

8. Describe the outfall location and design.

9. Provide the receiving water body name and 8-digit hydrologic unit code (HUC). Check all of the applicable beneficial uses. The applicable beneficial uses for Idaho water bodies can be found in IDAPA 58.01.02.100–160). Additionally, DEQ's interactive mapper is a useful tool for determining the applicable beneficial uses and whether the water body is impaired (and for which pollutants). (Available at: *https://mapcase.deq.idaho.gov/wq2012/*)

Information about public surface water intakes may be obtained from the Idaho Department of Environmental Quality. Information about private surface water intakes could be obtained from the water rights database maintained by the Idaho Department of Water Resources. Information about salmonid spawning could be obtained from the Idaho Department of Environmental Quality or from the Idaho Department of Fish and Game. The US Fish and Wildlife Service (*http://www.fws.gov/idaho/Species.htm*) should be contacted regarding the presence of threatened or endangered species.

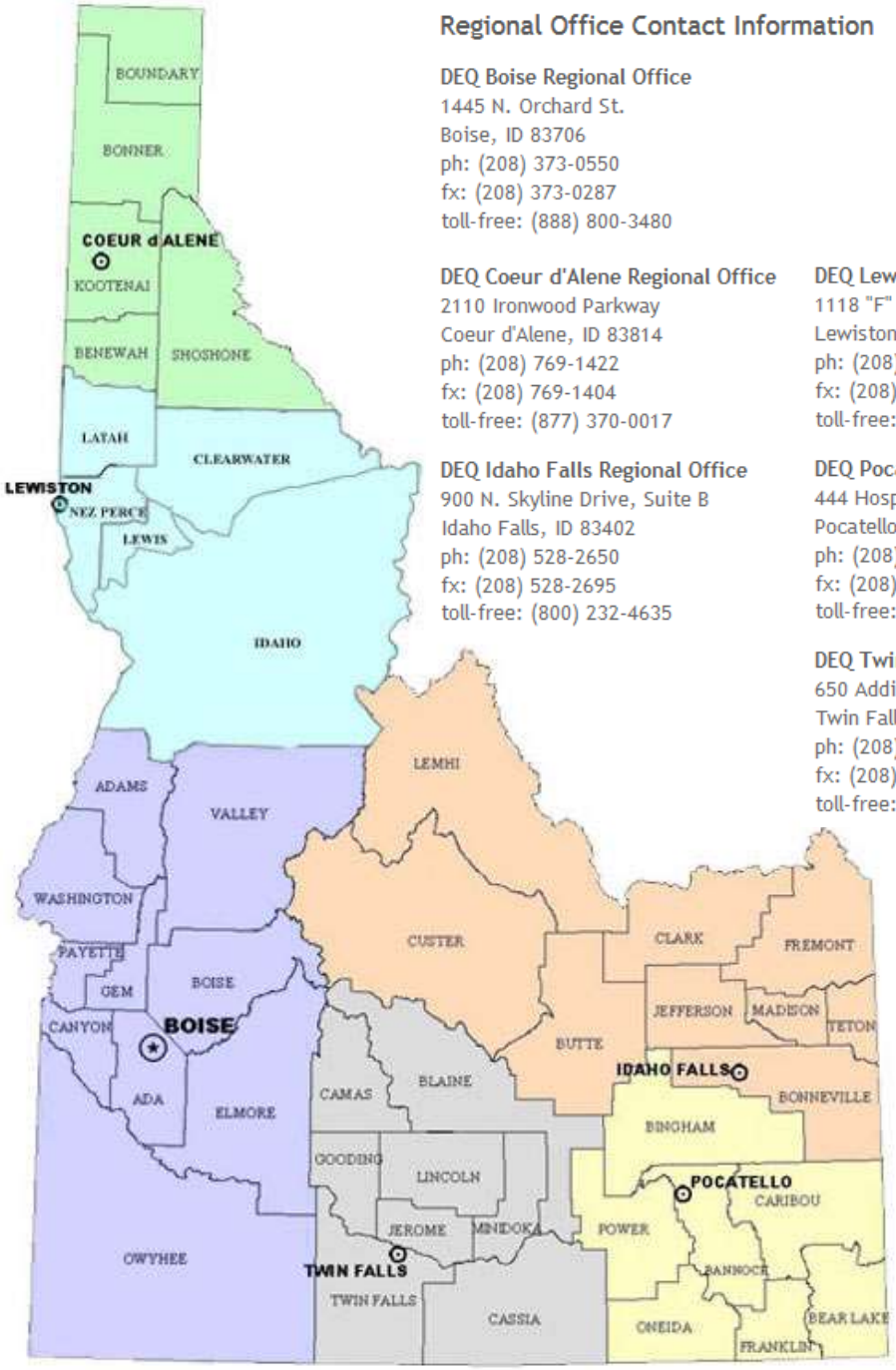
10. Provide the mixing zone size and configuration information. At a minimum, the percentage of flow and associated dilution factor must be listed. The length and width information should be listed when modeling is conducted. Check the appropriate box regarding whether the mixing zone is shore-hugging.

11. Include information used in the modeling analysis (such as input values not already included on the form, model outputs, and information about assumptions used in the analysis).

12. Each application must have an original signature of the applicant and a date.

Submittal Information

When completed, please send the mixing zone request form and supporting information to the appropriate DEQ regional office. There is no processing fee associated with this submittal.



Regional Office Contact Information

DEQ Boise Regional Office
1445 N. Orchard St.
Boise, ID 83706
ph: (208) 373-0550
fx: (208) 373-0287
toll-free: (888) 800-3480

DEQ Coeur d'Alene Regional Office
2110 Ironwood Parkway
Coeur d'Alene, ID 83814
ph: (208) 769-1422
fx: (208) 769-1404
toll-free: (877) 370-0017

DEQ Lewiston Regional Office
1118 "F" St.
Lewiston, ID 83501
ph: (208) 799-4370
fx: (208) 799-3451
toll-free: (877) 541-3304

DEQ Idaho Falls Regional Office
900 N. Skyline Drive, Suite B
Idaho Falls, ID 83402
ph: (208) 528-2650
fx: (208) 528-2695
toll-free: (800) 232-4635

DEQ Pocatello Regional Office
444 Hospital Way, #300
Pocatello, ID 83201
ph: (208) 236-6160
fx: (208) 236-6168
toll-free: (888) 655-6160

DEQ Twin Falls Regional Office
650 Addison Avenue West, Suite 110
Twin Falls, ID 83301
ph: (208) 736-2190
fx: (208) 736-2194
toll-free: (800) 270-1663

Appendix C. Level of Analysis and Data Inputs

Data Description	Analysis Level[a]		
Outfall Information	**1**	**2**	**3**
Outfall location (Estimate from 1:24K topographic map or measure with a GPS receiver. When measured then provide the datum.)	E	M	M
Map	P	P	P
Photographs of the outfall and the vicinity of the outfall	O	O	P
Distance from nearest bank to discharge (m)	O	E	M
Height of outfall above stream bottom (m)	O	E	M
Diameter of port (m)	O	M	M
Discharge horizontal angle (σ)	O	M	M
Diffuser:			
Length of diffuser (m)		M	M
Distance from nearest bank to first port (m)		M	M
Distance from nearest bank to last port (m)		M	M
Total number of ports		M	M
Distance between ports (m)		M	M
Port vertical angle (θ)		M	M
Angle between diffuser line and ambient current (γ)		M	M
Angle between port centerline projection and diffuser axis (β)		M	M
Effluent Information			
Flow rate (MGD) and/or velocity (m/s)	E	E	M
Pollutant concentrations	P	P	P
Receiving Water Body Information			
Low flow (cfs) or velocity (f/s)	E	E	M
Channel depth (m)		E	M
Channel width (m)		E	M
Channel slope (degrees)		E	M
Manning's roughness coefficient		E	E
Ambient concentrations for pollutants in mixing zone		M	M
Model Information			
Model used		P	P
Basis for model selection		P	P
Mixing zone configuration/location		P	P
Model results table		P	P

[a] P = provide; E = estimate; M = measure (field or engineering plans); O = optional