

TECHNICAL MEMORANDUM



TO: Andy Koester, Arizona Department of Environmental Quality
FROM: Matthew Reusswig and Dan Connally, PG Environmental
DATE: June 29, 2018
SUBJECT: Recommendations for Modifications to Arizona Mixing Zone Water Quality Standards

Background

Arizona's Department of Environmental Quality (ADEQ) implements Arizona's surface water quality standards (WQS) in Arizona Pollutant Discharge Elimination System (AZPDES) permits consistent with federal and state regulations and departmental implementation provisions. Arizona's WQS are established at A.A.C R18-11 of Arizona's administrative code. In addition to beneficial use designations, narrative and numeric water quality criteria, and permit implementation procedures, the WQS contain standards and implementation language authorizing mixing zones and providing the basis for their implementation in AZPDES permits.

Mixing zone standards and implementation requirements should ensure that all authorized mixing zones will result in the ultimate attainment of narrative and numeric water quality criteria and the maintenance of a waterbody's designated uses. Once protection of water quality is ensured, regulations should be structured to provide the permitting authority with an appropriate level of flexibility and discretion in mixing zone implementation to create outcomes that are proportionate and appropriate to the circumstances of a given discharge.

The purpose of this memorandum is to identify and discuss alternative approaches to mixing zone WQS which are likely to provide equivalent or increased protectiveness of water quality when implemented through AZPDES permits. The alternatives identified in this memorandum are based on a comparative analysis of common mixing zone approaches used in other states and on PG Environmental's (PG) experience implementing mixing zones in National Pollutant Discharge Elimination System (NPDES) permits.

PG suggests that ADEQ consider the following changes to their water quality standards:

- Define additional critical flow conditions (effluent flow critical conditions, and critical conditions for different criteria types) for purposes of authorizing criteria and pollutant-specific mixing zones.
- Size mixing zones according to narrative functional performance standards, rather than fixed-numeric standards.

Critical Conditions and Criteria-Specific Mixing Zones

Mixing zones and their associated dilution credits or factors are typically sized based on modeling or field studies which account for critical low flow conditions. If a discharge is controlled such that it does not cause water quality criteria to be exceeded in the receiving water during critical flow conditions, then mixing zones and effluent limitations based on those critical conditions will likely be protective of water quality. Numeric criteria have duration and exceedance frequency components which are addressed through use of critical flow conditions with comparable averaging periods and recurrence frequencies.

In Arizona's WQS, "critical flow conditions" are defined as "the lowest flow over seven consecutive days that has a probability of occurring once in 10 years (7Q10)." The WQS do not establish critical conditions for effluent flows, nor do they specify different critical conditions for different types of criteria (e.g., acute aquatic life criteria, chronic aquatic life criteria, human health criteria, or other parameter classes).

PG recommends defining additional critical conditions applicable to effluent flows. Establishing critical conditions for effluent flows in the water quality standards will encourage consistency between mixing zone authorizations within the state. Use of a common set of critical conditions for effluent flows will also help to ensure inputs used to model mixing behavior are protective of the criteria of interest.

Common effluent flow critical conditions observed in other states' water quality standards include:

- **Acute Aquatic Life Criteria:** Maximum permitted effluent daily flow rate, or maximum observed daily effluent flow rate.
- **Chronic Aquatic Life Criteria:** Average monthly effluent flow rate.
- **Human Health Criteria (or other long-duration criteria):** Average monthly effluent flow rate, or long-term average effluent flow rate.

In addition, PG recommends defining additional critical conditions for receiving water flows. Like Arizona, many states make exclusive use of 7Q10 low flow values in their WQS. However, defining different critical low flow conditions for different criteria would allow Arizona permit writers to more closely tailor the size of any mixing zone to the criteria of interest (e.g., a protective mixing zones for human health criteria would be larger than other types, while mixing zones for acute aquatic life criteria would tend to be smaller and more restrictive).

Acute aquatic life criteria are typically meant to be protective of 1-hour average duration events. The 7-day average low flow event (7Q10) are often well in excess of minimum 1-day flows (e.g., 1Q10) or flow events of shorter duration, which means that a mixing zone based on the 7Q10 low flow and applied to an acute criterion may not be protective of water quality in all circumstances. Many states apply a 1-day average low flow to mixing zones for acute criteria to

minimize the risk of an exceedance of water quality criteria outside of the mixing zone. Conversely, human health criteria are based on long-term exposure durations (e.g., 70 years) and use of a 7Q10 for these criteria may result in an excessively small mixing zone.

PG recommends assigning additional low flow receiving water critical conditions for specific criteria types to allow for appropriate sizing of mixing zones based on exposure risk and exceedance frequencies. Common receiving water low flow critical conditions used in other states include:

- **Acute Aquatic Life Criteria:** 1Q10 low flow, or 1B3 low flow.
- **Chronic Aquatic Life Criteria:** 7Q10 low flow, or 4B3 low flow. Some states use the 30Q10 or 30B3 low flows for chronic ammonia criteria.
- **Human Health Criteria (or other long-duration criteria):** harmonic mean receiving water flow rate.

Fixed-Numeric Mixing Zone Sizing Standards

Section 114(H) of the WQS includes mixing zone requirements which prevent a mixing zone from dominating the water body and ensure a non-toxic path of travel for passing organisms. Both are important and necessary elements of any protective mixing zone authorization. PG recommends that fixed-numeric sizing standards for flowing rivers and streams be re-formulated as narrative standards to provide the permitting authority with greater discretion in establishing protective mixing zones.

The numeric standards applicable to flowing streams and rivers in Section 114(H) include:

1. The length of the mixing shall not exceed 500 meters in a stream
4. A mixing zone shall provide for a zone of passage of not less than 50 percent of the cross-sectional area of a river or stream.
6. The size of the zone of initial dilution in a mixing zone shall prevent lethality to organisms passing through the zone of initial dilution.

The use of a numeric maximum downstream length in a mixing zone WQS is typically adopted to prevent a mixing zone from dominating the waterbody. However, the use of a numeric maximum tends to become the default mixing zone size in permit authorizations as permittees seek to maximize their dilution credit.

In place of the 500-meter maximum sizing requirement Section 114(H)(1), PG would recommend the following alternative standards designed to prevent a mixing zone from dominating the waterbody:

- Mixing zones shall be as small as feasible and practicable.

- Mixing zones size shall not exceed the zone of initial dilution under critical conditions, nor shall a mixing zone extend beyond the point in a waterbody wherein complete mixing occurs.
- Mixing zones may be applied by the permitting authority on a pollutant-by-pollutant basis.

By requiring mixing zones to be as small as feasible (i.e., no larger than necessary to produce water quality-based effluent limitations which can be feasibly complied with), this requirement would tend to minimize the size of mixing zones and incentivize permittees to maintain their current level of treatment. It also clarifies that, while the WQS authorize the permitting authority to grant dilution in permits, the WQS preference the minimization of granted dilution.

Requiring that mixing zones not exceed either the zone of initial dilution nor the point where complete mixing occurs would clarify that mixing zones may only be applied in zones where physical mixing is occurring and is predictable. There is no water quality benefit for authorizing a regulatory mixing zone in portions of a waterbody where mixing is not occurring at appreciable levels.

PG would recommend removing Section 114(H)(4) as it is duplicative of 114(H)(6) based on the WQS definition of “zone of passage”. According to the WQS, a zone of passage is “a continuous water route of volume, cross-sectional area, and quality necessary to allow passage of free-swimming or drifting organisms with no acutely toxic effect produced on the organisms.” The definition requires a zone with no acutely toxic effects (e.g., resulting in exposure levels that exceed the acute aquatic life criterion on a 1-hour average basis). It does not require a continuous zone or route where aquatic life criteria are met at all points.

This definition and the 50 percent zone of passage requirement suggest that a mixing zone could be authorized which does not result in acute toxicity for half the water, but could result in acute toxicity in the other half. However, according to Section 114(H)(6), a mixing zone is prohibited from resulting in acutely toxic effects along all travel paths and is a more stringent requirement than (H)(4).

PG recommends removing Section 114(H)(4) since it would allow for the establishment of mixing zones which result in acutely toxic effects. Prohibiting mixing zones which would result in acutely toxic effects is a reasonable standard and is common in state water quality standards. Instead, PG would recommend retaining the narrative prohibition in 114(H)(6) and add an additional clause that states that mixing zones may not prevent passage for fish or other passing organisms. This approach would reduce confusion and result in regulatory mixing zones which are as protective as under the current standards.

- The size of the zone of initial dilution in a mixing zone shall prevent lethality to organisms passing through the zone of initial dilution, nor shall the mixing zone prevent passage of free-swimming or drifting organisms.

PG reviewed the mixing zone sizing requirement at Section 114(H) specific to lakes and reservoirs and did not have any comments or alternative approaches to recommend.

As Arizona investigates revisions to their mixing zone sizing WQS, the general goals PG would recommend keeping at the forefront would be:

- Incentivize minimizing the size of mixing zones while providing the permitting authority discretion and flexibility to address a diverse range of permitting circumstances.
- A mixing zone which prevents the attainment of a designated use should not be authorizable (e.g., results in acute toxicity or fish kills, interferes with drinking water or recreational uses, etc.).

Conclusion

Based on PG's review of Arizona's WQS, PG recommends investigating mixing zone sizing approaches which provide narrative performance standards which specify the desired outcome (e.g., mixing zones must be as small as feasible), rather than fixed-numeric standards (e.g., mixing zones shall not exceed 500 meters in length). Fixed-numeric standards have the benefit of clarity and specificity; however, they lack flexibility in implementation and can result in mixing zones which are poorly sized for the circumstances of the waterbody and the discharge.

PG recommends more narrowly tailoring mixing zones to the type of criteria being considered in permits and clearly articulating that mixing zone size should be minimized to the maximum extent feasible. When paired with standards that require mixing zones to prevent acutely toxic effects and to allow for safe transit of aquatic life, the resulting mixing zones are likely to be as protective or more protective than mixing zones implemented under the existing standards.