Appendix H: Preliminary Considerations for the Development and Implementation of Water Quality Based Effluent Limitations

Introduction

This document presents Ecology's preliminary strategies, potential approaches, and considerations for calculating and implementing Water Quality Based Effluent Limits (WQBELs) for National Pollutant Discharge Elimination System (NPDES) permits that must include requirements to reduce nitrogen loading to Puget Sound. Our intent is to provide an initial framework for further discussion and collaboration with interested parties. We welcome comments on this document and will consider public feedback in our next steps.

This appendix outlines potential strategies, approaches and considerations for implementing nitrogen water quality-based effluent limits (WQBELS) as part of Ecology's broader Puget Sound nutrient reduction effort, as reflected in the draft Puget Sound Nutrient Reduction Plan.

Technical Advisory Committee

Important decisions remain, and input is needed, before Ecology determines how targets presented in the draft Puget Sound Nutrient Reduction Plan are translated into WQBELs. To continue this work, and provide a forum for input from regulated and impacted communities, Ecology plans to establish a Technical Advisory Committee (Committee) to seek recommendations and support for the development and implementation of WQBELs. We intend to invite a wide array of participants, including: Puget Sound cities, counties, water and sewer districts, industry, the scientific community, universities, environmental organizations, Tribes, state and federal agencies. This Committee will work to develop and guide the implementation of WQBELs for future NPDES permits and provide input to help Ecology evaluate key decisions such as:

- the approach for translation of the targets in the draft Puget Sound Nutrient Reduction Plan results into WQBELs,
- the structure and timing of compliance tools, and
- selection of the averaging period used to form the basis of the WQBEL.

Ecology could implement WQBELs through the establishment of compliance schedules, or interim WQBELs.

Ecology plans to convene the Committee in 2026 and will provide more information about its development outside of this document.

EPA Guidance for Developing Nutrient WQBELs

The U.S. Environmental Protection Agency's (EPA) Technical Support Document for Water Quality-Based Toxics Control (1991)[1] has traditionally served as the primary framework for calculating WQBELs in NPDES permits. EPA's Technical Support Document applies to pollutants like toxics and metals, where water quality criteria are typically based on short-term (acute) and long-term (chronic) exposure durations—usually less than 30 days and typically one hour or four days, respectively.

The Technical Support Document uses statistical methods to derive a long-term average (LTA) of effluent quality. From the LTA, it applies fixed multipliers to calculate average monthly limits (AML), average weekly limits (AWL), and/or maximum daily limits (MDL) which account for effluent variability while still protecting water quality.

This approach is appropriate for pollutants that exhibit direct and immediate toxicity to aquatic life, such as ammonia or copper. Nutrients like nitrogen have different dynamics and pose indirect, cumulative risks such as algal blooms or decreasing dissolved oxygen over a long period of time. Limitations of the Technical Support Document approach for nutrient WQBELs include its assumption of short-duration, constant exposure conditions which do not reflect how nutrient pollution behaves over a seasonal or annual basis.

In recognition of these limitations, EPA issued the Chesapeake Bay Memorandum in 2004[2], explicitly supporting the use of long term-average WQBELs for nutrients rather than short term averages (e.g., AML, AWL or MDL). EPA acknowledged that nutrient criteria and TMDL wasteload allocations (WLA) are often based on annual or seasonal modeling. The memo also confirms that when WQBELs are derived from WLAs with long-term averaging periods, the permit may also express limits as long-term averages. It also emphasizes the importance of permit limit consistency with the assumptions of the TMDL or water quality model, including timeframes and averaging periods. Ecology is using this guidance in support of developing annual or seasonal average total nitrogen WQBELs for Puget Sound dischargers.

To provide additional clarity on nutrient WQBEL development, EPA outlined three permit limit development methodologies in its *NPDES Permit Writer's Specialty Training: Addressing Nutrient Pollution*.[3] These methodologies are as follows:

[1] https://www3.epa.gov/npdes/pubs/owm0264.pdf
[2] https://www3.epa.gov/npdes/pubs/memo_chesapeakebay.pdf
[3] https://www.epa.gov/npdes/npdes-permit-writers-specialty-training-addressing-nutrient-pollution-npdes-permits

1. Set WQBEL = Wasteload Allocation (WLA)

- The WLA is expressed as a seasonal or annual average.
- Sets the WQBEL directly equal to the WLA without any changes. This is the simplest and most direct approach and is valid when the WLA is protective and based on modeling or TMDL analysis.

2. Assume WLA = LTA and apply unmodified Technical Support Document methods

- The WLA can reasonably be interpreted as a long-term average.
- Uses standard Technical Support Document procedures to translate the LTA into an AML/AWL/MDL using established statistical multipliers. Limits calculated in this way are likely overly conservative or imprecise depending on the averaging period of the WLA.

3. Adapt Technical Support Document methods to match the duration of the WLA

- A customized approach to reflect the specific duration (e.g., seasonal or annual) of the nutrient WLA.
- Modifies the Technical Support Document statistical procedures to account for the lognormal distribution of effluent concentrations over longer averaging periods.

Ecology is evaluating how to implement nitrogen WQBELs for dischargers in the Puget Sound region, working to ensure that permit limits will be protective, reasonable, and achievable. While EPA has provided these permitting methodologies, Ecology has not yet finalized a preferred approach. The unique characteristics of Puget Sound, including its complex hydrodynamics and cumulative nature of nutrient loading across multiple dischargers, present additional technical and policy challenges. As a result, Ecology is considering how to align future permit requirements with both EPA guidance and the underlying modeling assumptions used in the draft Puget Sound Nutrient Reduction Plan and the Budd Inlet TMDL.

Budd Inlet TMDL

EPA approved the Budd Inlet Total Maximum Daily Load (TMDL)[4] in 2022, following nearly two decades of scientific research and analysis focused on addressing dissolved oxygen impairments in the southernmost inlet of Puget Sound.

[4] https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Total-Maximum-Daily-Load-process/Directory-of-improvement-projects/Deschutes-River-watershed-area-Budd-Inlet

While the Salish Sea Model scenarios were aligned with the conceptual framework of the TMDL, the specific nitrogen load targets produced through the Salish Sea Model effort did not match the final WLAs established in the Budd Inlet TMDL. Ecology acknowledges that these inconsistencies between the TMDL and the draft Puget Sound Nutrient Reduction Plan NRP create uncertainty for permittees in Budd Inlet. The EPA-approved TMDL guides the development of final WQBELs in future permit cycles; however, there may be opportunities to address SSM assumptions to produce outputs that more closely align with the TMDL's WLAs.

Ecology seeks feedback on addressing the discrepancies between the draft Puget Sound Nutrient Reduction Plan point source load targets and the final Budd Inlet TMDL WLAs.

Basin-wide Loading and Facility Allocations

The nitrogen targets described in the draft Puget Sound Nutrient Reduction Plan, are divided by marine point sources and watersheds, consistent with the structure of nutrient loading inputs in the Salish Sea Model. Targets are aggregated to each of the eight basins in Puget Sound. These basin-level targets support Ecology's ability to reallocate nutrient loading between sources within a basin.

Currently, Ecology is considering three options for translating the nitrogen loads from the targets in the draft Puget Sound Nutrient Reduction Plan into WQBELs. These options for translating loading rates would need to account for existing TMDLs and WLAs, as described earlier. We are open to feedback on alternative approaches beyond these three options.

Option 1

Direct translation of annual nitrogen loads from the Puget Sound Nutrient Reduction Plan into annual or seasonal limits. The benefit of this approach is that it is simple and ensures that the WQBELs will achieve the Water Quality Standards by matching the exact scenario used in the model.

Option 2

Start with the basin loads from the Puget Sound Nutrient Reduction Plan and allocate loads to each facility based on their percentage of current total effluent volume or nitrogen loading within each basin. This current flow or loading could use more recent data and average over a period longer than a year (e.g. the last five years). This approach provides consideration for changes in operation since 2014, but does not account for already known growth or expansion.

Option 3

Allocate basin loads to each facility based on their percentage of total permitted maximum monthly design flow. This method provides the greatest consideration for future expansion but does not recognize facilities reductions in loading achieved during optimization nor incentivize facilities to reduce overall effluent flows rates (e.g. via reclaimed water generation during critical summer months).

Ecology is interested in feedback as to preferred options or alternative approaches to translating modeling results into WQBELs.

Selecting Pollutants for Limits

The Salish Sea Model identified two pollutants which must be limited to achieve compliance with water quality standards for dissolved oxygen. These two pollutants are nitrogen and carbon expressed as 5-day carbonaceous biological oxygen demand ($CBOD_5$).

$CBOD_5$ is a commonly monitored pollutant at both domestic WWTPs and industrial facilities. For this reason, Ecology believes it is best to establish limits and monitoring for $CBOD_5$ directly. Although the Salish Sea Model assumed specific $CBOD_5$ concentrations as model inputs ($CBOD_5$ 8 mg/L year-round), the draft Plan does not identify specific loads for this parameter for each facility. Ecology would like input from interested parties on the development of WQBELs for $CBOD_5$.

There are a variety of different parameters used to assess the nitrogenous load to the Puget Sound including total Kjeldahl nitrogen (TKN), dissolved inorganic nitrogen (DIN), total inorganic nitrogen (TIN), and total nitrogen (TN). The Salish Sea Model and 2022 Puget Sound Nutrient General Permit (PSNGP) use DIN and TIN, respectively. Looking forward, Ecology believes TN is the best parameter to use for Puget Sound Nutrient Reduction Plan-related permit limits and monitoring.

Total nitrogen includes both organic and inorganic forms of nitrogen. From an ecological perspective, both organic and inorganic forms of nitrogen can cause oxygen depletion in the environment. The nitrogen removal processes at many domestic WWTPs start by converting organic forms of nitrogen to inorganic forms (e.g. nitrate and nitrite) before finally converting them into nitrogen gas (N_2). Monitoring for TIN alone, especially in domestic WWTPs, can result in the false impression that their treatment process is generating nitrogen when in fact they are simply converting influent organic nitrogen to an inorganic form.

Loads vs. Concentration

Federal regulations, 40 CFR 122.45(f)(1), require that WQBELs be established on a mass basis also known as a "load unless this requirement is determined to be infeasible, on a case-by-case basis." Mass limits provide permittees with more flexibility than concentration limits to achieve compliance because in addition to reducing concentration, permittees may also reduce effluent volume as a means of reducing loading.

Ecology could translate mass-based limits into concentration-based limits, but any such limit would need to pair with a flow limit. The Salish Sea Model used actual 2014 effluent flows rates from domestic WWTPs and industrial facilities when determining what loading scenarios would achieve compliance with water quality standards.

Another option is to use each facilities currently permitted maximum month flow rate and calculate the associated concentration required to achieve the loading limits presented in Appendix E. This would result in extremely low limits for many facilities (e.g. <1 mg TN/L).

A third option would be to use the facility's annual average flow to derive a concentration-based limit.

Ecology believes the best approach is to use mass-based loading limits unless a permittee specifically requests concentration-based limits.

Ecology seeks feedback on the appropriate flow statistic to use as a limit if a permittee requests a concentration-based effluent limit in lieu of a loading.

Effluent Limit Averaging Period

Using an annual (or seasonal) average for nutrient limits in NPDES permits dovetails with the longer averaging periods of pollutants like nitrogen that cause cumulative impacts over time. Nutrient-related water quality issues like algal blooms and low dissolved oxygen generally stem from sustained loading rather than short term spikes. As such, longer averaging periods better reflect the way nutrients behave in the receiving water environment.

A seasonal or annual average load aligns with the Salish Sea Model results and the draft Puget Sound Nutrient Reduction Plan, while providing more flexibility for facilities. Facilities can adjust operations to accommodate fluctuations in influent flow and strength, cold seasonal treatment challenges, or planned maintenance without being penalized for short-term effluent variability – provided the overall averaged effluent limit is met.

Ecology would like feedback on the preferred averaging period selected for final WQBELs.

Longer-term NPDES Compliance Tools

Ecology committed to using a phased implementation strategy with the issuance of the first PSNGP. This commitment supports Ecology's long-term goal of meeting WQBELs (and water quality standards) by 2050. The approach allows dischargers to plan, design, and construct nutrient reduction measures while making progress toward improving water quality in Puget Sound. Given the economic burden communities may face by investing in nutrient control technologies for their wastewater treatment plants that are designed to achieve the necessary nitrogen levels, a phased implementation approach will provide a path towards meaningful improvements with reasonable investments over time.

Compliance Schedules

Ecology may develop and implement compliance schedules in NPDES permits to provide permittees with a structured timeline for meeting final nutrient WQBELs. Federal and state regulations require these schedules to include specific milestones for progress, such as completing engineering studies, securing funding, and constructing treatment upgrades. Compliance schedules may allow time for all facilities to meet their final nutrient WQBELs no later than 2050, with measurable progress expected during each permit cycle.

In developing compliance schedules, Ecology will consider the economic impacts and financial feasibility of required treatment upgrades. Ecology acknowledges that significant infrastructure investments may be necessary to meet the final nutrient WQBELs and that municipalities can use various approaches to limit the burden of increased rates on community members. As a moderating strategy, Ecology will consider a phased implementation approach that focuses first on investments to comply with a reasonable technology-based treatment standard. The nutrient reduction evaluations and AKART (all known, available, and reasonable methods of prevention, control, and treatment) studies required by the first version of the PSNGP will aid in establishing this treatment standard.

Ecology would like feedback on establishing this technology standard.

Interim Limits

Concurrently with compliance schedules, Ecology may develop and implement interim effluent limits in NPDES permits. Interim limits are intended to maintain progress toward compliance with water quality-based effluent limits, while remaining within the current treatment capacity of the permittee.

Performance-based limits are typically established based on the 95th percentile of current concentrations or loads. Ecology plans to use this method for interim limits in permits when a compliance schedule is incorporated as discussed above.

Ecology may also set interim limits consistent with the AKART standard for facilities that already achieve this level of treatment. Likewise, any facility designed and constructed to achieve the AKART standard may have an interim AKART-based limit rather than a performance-based limit. Interim limits may also require phased incremental reductions in nutrient discharges where feasible.

Variances

A water quality standards variance is a regulatory tool that may be adopted into rule by Ecology if dischargers cannot meet their effluent limits and there is uncertainty on whether the effluent limit can ultimately be met. A variance is a time-limited designated use and time-limited criterion for a specific pollutant(s) or water quality parameter(s) that reflect the highest attainable condition during the term of the water quality standard variance. A variance allows for reductions in pollutants over time to reach the underlying water quality standard. Ecology may issue variances for individual facilities, a group of facilities, or stretches of waters.

Variance applications must include all elements described in WAC 173-201A-420. These requirements include but are not limited to a justification for the variance based on six factors found in 40 CFR 131.14, supporting water quality data characterizing discharges and the receiving water body, technology feasibility analysis, alternatives analysis, actions needed to meet the effluent limits, and a timeline to accomplish each corrective action aimed at meeting the underlying standard. Entities should coordinate with Ecology's permitting and water quality standards staff early in the variance application development process to ensure applications have all necessary information. After Ecology receives a variance application, the Agency determines if there is sufficient information to consider adopting variances into the water quality standards through a formal rulemaking process.

During the rulemaking, Ecology will consider the information provided in the variance applications, analysis from our permit managers and facility engineers on water quality data, technology feasibility, and corrective actions, as well as any additional input provided through the rulemaking process, to develop the variances and determine whether it is appropriate to adopt one or more of them into the standards.

Ecology must conduct a public review of an adopted variance at least every five years throughout the course of the variance to determine that the conditions of the variance are met, and that the variance is still necessary. Ecology must submit the results of this interim review to EPA, otherwise it becomes invalid.

Next Steps and Technical Advisory Committee Formation

We believe input from permittees, non-governmental organizations, Tribes, technical experts, and other interested parties is critical as Ecology continues to develop our nutrient-related WQBELs.

Ecology's next step is to consider public feedback on the approaches described in this Appendix via the comment period for the draft Puget Sound Nutrient Reduction Plan. Assuming comments received are supportive of continued discussion, Ecology plans to proceed with the formation of a Technical Advisory Committee by determining a topical framework and schedule for the Committee's work. Once the framework and schedule are established, Ecology will share information on how to participate in a Technical Advisory Committee.