Executive **Summary**

WATER ENVIRONMENT & REUSE FOUNDATION

Crafting appropriate nutrient discharge permits

Nutrient Management Volume III: Development of Nutrient Permitting Frameworks (NUTR1R06z)

The Central Issue

Point source NPDES permitted dischargers are the most directly regulated sources subject to nutrient control requirements resulting from numeric nutrient standards, total maximum daily loads (TMDLs), and water quality-based permit limits. The U.S. EPA's efforts to promulgate numeric nutrient standards in all states raise questions about how these standards apply to wastewater dischargers, whether they are effective, and how they affect others in the water quality sector. Targeted nutrient levels in lakes, streams, and estuaries can be very low concentrations that are challenging to meet. Nutrient removal treatment can substantially reduce point source discharges of nitrogen and phosphorus, however substantial investments are required to build and operate advanced wastewater treatment facilities. In some watersheds, nonpoint source nutrient loadings outweigh point sources to a degree that advanced treatment for nutrient removal, and even complete elimination of point sources, would have limited benefit to water quality.

Context and Background

This report combines the findings of two previous studies conducted under WE&RF's Nutrient Removal Challenge (*Nutrient Management: Regulatory Approaches to Protect Water Quality – Volume I: Review of Existing Practices* (NUTR1R06i) and *Nutrient Management – Volume II: Removal Technology Performance and Reliability* (NUTR1R06k)) and case study experiences to present a discussion of nutrient discharge permitting and the variety of potential approaches to establishing effluent limits for nitrogen and phosphorus. The researchers provide an overview of current practices with a few key issues facing wastewater effluent dischargers. The traditional permit writers' deterministic approach to developing effluent limits is presented in context of nitrogen and phosphorus. The researchers also present additional approaches to nutrient discharge permitting that provide greater flexibility, while at the same time arrive at limits that are protective of water quality. The report documents a wide variety of nutrient permit structures utilized across the country and the benefits of the application of more sophisticated methods to develop effluent nutrient limits (including water quality models, technology performance statistics, and probabilistic methods to arrive at permit structures that better match actual receiving water requirements).

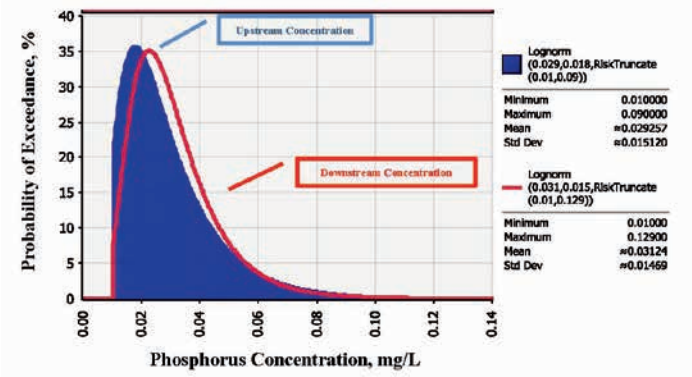
Findings and Conclusions

A great variety of approaches to establishing effluent limits for nitrogen and phosphorus have been adopted across the country and some have resulted in very restrictive conditions that may exceed the capabilities of advanced nutrient removal treatment. It is preferable to structure discharge permits in such a way that receiving water quality objectives are met with the greatest flexibility that can be provided to the treatment processes. This is important in order to avoid unnecessary restrictive effluent discharge conditions that result in little additional water quality protection, but rather as part of the treatment process which consume inordinate amounts of energy and chemicals that result in other deleterious environmental impacts. More appropriate nutrient discharge permits may be developed when conditions include:

- Collaboration between permit writers and permittees.
- Shared understanding of the frequency and duration associated with watershed nutrient management objectives.
- Shared understanding of the capabilities of advanced nutrient removal treatment.
- Recognition of the environmental trade-offs associated with nutrient removal treatment and discharge permit structures.
- Recognition of the variability in effluent characteristics and the natural environment.
- Application of more sophisticated methods, water quality models, and statistical tools to arrive at permit structures that better match actual receiving requirements.

Management and Policy Implications

Permit writers and permittees should collaborate in crafting nutrient discharge permits to allow for the greatest amount of flexibility possible in the structure of nutrient limits that preserve the opportunity for the most creative and economical ways to manage nutrients. The project team provides a permit writers' workshop curriculum for nutrient discharge permitting which includes an annotated agenda describing the workshop modules and sample exercises.



Upstream and Downstream Phosphorus Concentrations vs. Probability Distribution.

Example of Probabilistic Approach to Calculation of Allowable Effluent Limits

Sample Event	WWTF Flow (cfs)	Upstream River Flow (cfs)	Upstream River Concentration (mg/L)	Downstream Flow (cfs)	Downstream Target Concentration (mg/L)	Calculated Effluent Concentration to Meet Target (mg/L)
Estimated Minimum	14.0	100	0.06	100	n/a	17.8
Estimated Maximum	18.0	8,000	0.099	8,000	n/a	0.1
Monte Carlo 50th Percentile						1.37
Monte Carlo 95th Percentile						0.65

Related WE&RF Research

Project Title	Research Focus
Uptake by Algae of Dissolved Organic Nitrogen from BNR Treatment Plant Effluents (NUTR1R06e)	Examines the premise that a credible and professionally accepted method to measure forms of DON that are not readily taken up by algae can be used by WRRF operators and regulators to more effectively understand and control eutrophication.
Nutrient Management: Regulatory Approaches to Protect Water Quality Volume I: Review of Existing Practices (NUTR1R06i)	Provides a better understanding of the unique challenges that utilities and regulators face setting and meeting low nutrient effluent limits, and expands the current understanding of the practical capabilities of nitrogen and phosphorus treatment.
Nutrient Management Volume II: Removal Technology Performance and Reliability (NUTR1R06k)	Looks at a comprehensive study of nutrient removal plants designed and operated for three or more years to meet very low effluent total nitrogen and total phosphorus concentrations to help inform decision makers about proper choices for both technologies and rationale bases for statistical permit writing.
Phosphorus Fractionation and Removal in Wastewater Treatment: Implications for Minimizing Effluent Phosphorus (NUTR1R06l)	Investigates a number of wastewater treatment configurations to determine the various phosphorus fractions, and their fate and susceptibility to a range of different phosphorus removal processes.
The Bioavailable Phosphorus (BAP) Fraction in Effluent from Advanced Secondary and Tertiary Treatment (NUTR1R06m)	Investigates the current analytical methods, speciation of P in different wastewater treatment processes, and the influence and effect of various molecular forms of P on algae growth.
Striking the Balance Between Nutrient Removal in Wastewater Treatment and Sustainability (NUTR1R06n)	Provides a bench-top analysis on finding the balance between nutrient removal and sustainability and examines whether a point of diminishing returns is reached where the sustainability impacts of achieving increased levels of nutrient removal outweigh the benefits of better water quality.
Nutrient Speciation and Refractory Compounds in Water Quality Models (NUTR1R06aa)	Communicates the need to apply the most contemporary understanding of the changes in effluent nutrient speciation and bioavailability that occur in advanced wastewater treatment that can be included in water quality modeling.
Mineralization Kinetics of Soluble Phosphorus and Soluble Organic Nitrogen in Advanced Nutrient Removal Effluents (NUTR1R06p)	Examines the dissolved phosphorus uptake kinetics characterization for five treatment facilities in the Spokane, Washington region.
Spokane Regional Wastewater Phosphorus Bio-Availability Study (NUTR4C09)	Uses algal bioassays to determine bioavailable phosphorus (BAP) of effluent treated by the pilot projects at the main WWTP discharges to the Spokane River.

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