Final **Report**

Nutrient Management Volume III: Development of Nutrient Permitting Frameworks

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NUTRIENT MANAGEMENT VOLUME III: DEVELOPMENT OF NUTRIENT PERMITTING FRAMEWORKS

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The Water Environment & Reuse Foundation (WE&RF) is a 501c3 charitable corporation seeking to identify, support, and disseminate research that enhances the quality and reliability of water for natural systems and communities with an integrated approach to resource recovery and reuse; while facilitating interaction among practitioners, educators, researchers, decision makers, and the public. WE&RF subscribers include municipal and regional water and water resource recovery facilities, industrial corporations, environmental engineering firms, and others that share a commitment to cost-effective water quality solutions. WE&RF is dedicated to advancing science and technology addressing water quality issues as they impact water resources, the atmosphere, the lands, and quality of life.

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ABSTRACT AND BENEFITS

Abstract:

Utilities work with regulators to treat wastewater to levels that protect human health and receiving water quality. Water quality criteria and permits are based on scientifically defensible and shared understanding of sources of pollutants in a watershed, as well as treatment capabilities and costs to control these in the aquatic environment. The national discussion of nutrient impacts on water quality continues to evolve – issues in high visibility waterbodies such as the Chesapeake Bay, Long Island Sound, Gulf of Mexico, San Francisco Bay, and Puget Sound highlight this. The U.S. Environmental Protection Agency's (EPA) 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 arena. A Water Environment Research Foundation (WERF) report, *Nutrient Management: Regulatory Approaches to Protect Water Quality, Volume 1 Review of Existing Practices* (NUTR1R06i) provides a state-of-the art discussion of key nutrient management issues that confront point source wastewater dischargers nationwide. A second WERF report, *Nutrient Management Volume II: Removal Technology Performance & Reliability* (NUTR1R06k) presents a comprehensive study of nutrient removal plants designed and operated to meet very low effluent nitrogen and phosphorus concentrations. This report combines the findings of the previous WERF studies with case study experiences for a third volume focused on nutrient discharge permitting.

Benefits:

- Presents an overview of nutrient discharge permitting practices ranging from traditional deterministic approaches to multiple ways of developing more appropriate effluent limits for nutrients.
- Highlights the limitations of the traditional deterministic approach to nutrient permitting based on guidance developed for toxics that are likely to result in overly restrictive limits for nutrients.
- Documents a wide variety of nutrient permit structures have been utilized across the country and that flexibility is available for permit writers to prepare permits that are both protective of water quality and technically feasible for successful compliance.
- Documents 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.
- Emphasizes that nutrient discharge permitting should focus on providing the greatest amount of flexibility possible in the structure of nutrient limits in order to preserve the opportunity for the most creative and economical ways to manage nutrients, including watershed management, water quality trading, reuse, recharge, and restoration.

Keywords: WERF Nutrient Removal Challenge, bioavailability, effluent limits, nitrogen, nutrient removal, nutrient criteria, numeric nutrient standards, NPDES permit, phosphorus, total maximum daily load, TMDL, trading, variance, water quality.

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AAC	Academic Advisory Committee
AHOD	Areal hypolimnetic oxygen deficit
AMELs	Average monthly effluent limits
AML	Average Monthly Limitation
AU	Assessment unit
AWWTF	Advanced Wastewater Treatment Facility
BACWA	Bay Area Clean Water Agencies
BAF	Biological aerated filter
BAP	Bioavailable phosphorus
BAT	Best available technology
BMP	Best Management Plan
BMPs	Best management practices
BNR	Biological nutrient removal
BOD	Biochemical oxygen demand
BOD5	Five-day biochemical oxygen demand
BPJ	Best professional judgment
BPT	Best practicable technology
BPWTT	Best Practicable Waste Treatment Technology
CBOD	Carbonaceous biochemical oxygen demand
CBOD5	Five-day carbonaceous biochemical oxygen demand
CCCSD	Central Contra Costa Sanitary District
CCME	Canadian Council of Ministers of the Environment
C_d	Downstream concentration
C_e	Effluent concentration
Chl	Chlorophyll
CSOs	Combined sewer overflows
CWA	Clean Water Act
CWS	Clean Water Services
CV	Coefficient of variation
DEEP	Department of Energy and Environmental Protection
DEP	Department of Environmental Protection
DEM	Department of Environmental Management
DENR	Department of Environment and Natural Resources

DEQ	Department of Environmental Quality
DMR	Discharge Monitoring Report
DNR	Department of Natural Resources
DNREC	Department of Natural Resources and Environmental Control
DO	Dissolved oxygen
DOE	Department of Ecology
EBDA	East Bay Dischargers Authority
EBMUD	East Bay Municipal Utility District
EBPR	Enhanced biological phosphorus removal
EDF	Environmental Defense Fund
EMC	Environmental Management Committee
ENR	Enhanced nutrient removal
EPA	U.S. Environmental Protection Agency
EvPA	Everglades Protection Area
GHGs	Greenhouse gas emissions
GLWQA	Great Lakes Water Quality Agreement
HBPT	Highest and best practical treatment
HRFS	High rate flocculated settling
HRSD	Hampton Roads Sanitation District
IACET	International Association for Continuing Education and Training
IP	Implementation procedures
IWLA	Individual Waste Load Allocation
LOT	Limit of technology
LOTT	Lacey, Olympia, Tumwater, and Thurston County
LTA	Long-Term Average
MBR	Membrane bioreactor
MCES	Metropolitan Council Environmental Services
MDELs	Maximum daily effluent limits
MDL	Maximum Daily Limitation
MEPDES	Maine Pollutant Discharge Elimination System
Metro	Metropolitan Syracuse Wastewater Treatment Plant
mgd	Million gallons per day
MLE	Modified Ludzack-Ettinger
MOA/MOU	Memorandum of Agreement/ Memorandum of Understanding
MPCA	Minnesota Pollution Control Authority

MS4	Municipal Separate Storm Sewer System
MWRD	Denver Metro Wastewater Reclamation District
NCDAWG	Nutrient Criteria Development Advisory Work Group
NC DWG	North Carolina Division of Water Quality
NDN AS	Nitrification/Denitrification Activated Sludge
NH3-N	Ammonia nitrogen
NNEs	Nutrient Numeric Endpoints
NOx-N	Nitrate plus nitrate nitrogen
NPDES	National Pollutant Discharge Elimination System
NRCA	Neuse River Compliance Association
NR	Natural Resources
NRDC	Natural Resources Defense Council
NYSDEC	New York State Department of Environmental Conservation
ON	Organic nitrogen
ONRWs	Outstanding national resources waters
OP	Ortho-phosphate-P
OR DEQ	Oregon's Department of Environmental Quality
P	Phosphorus
PCBs	Polychlorinated Biphenols
PDH	Professional development hour
POTWs	Publicly Owned Treatment Works
RM	River mile
RPA	Reasonable potential analysis
RWCs	Receiving water concentrations
SFEI	San Francisco Estuary Institute
SFRWQCB	San Francisco Bay Regional Water Quality Control Board
SNRP	Soluble non-reactive phosphorus
SPDES	State Pollutant Discharge Elimination System
SRP	Soluble Reactive Phosphorus
SWIMS	Surface Water Integrated Monitoring System
SWRCB	State Water Resources Control Board
TBELs	Technology-based effluent limitations
TCEQ	Texas Commission on Environmental Quality
TIC	Trophic Index Criterion
TIN	Total inorganic nitrogen

TMDLs	Total maximum daily loads
TN	Total nitrogen
TNRP	Total nonreactive phosphorus
TP	Total phosphorus
TPS	Technology performance statistics
TRP	Total reactive phosphorus
TSD	Technical Support Document
TSS	Total suspended solids
UAA	Use Attainability Analysis
UCT	University of Cape Town process
USGS	United States Geological Survey
VNRP	Voluntary Nutrient Reduction Program
VPDES	Virginia Pollutant Discharge Elimination System
WAC	Washington Administrative Code
WEF	Water Environment Federation
WEFTEC	Water Environment Federation Technical Exhibition and Conference
WERF	Water Environment Research Foundation
WE&RF	Water Environment & Reuse Foundation (formerly WERF)
WET	Whole Effluent Toxicity
WIPs	Watershed Implementation Plans
WLAs	Wasteload allocations
∑WLA	Sum of Waste Load Allocations
WPCF	Water Pollution Control Facility
WPDES	Wisconsin Pollution Discharge Elimination System
WQBELs	Water quality-based effluent limits
WQCC	Water Quality Control Commission
WQC	Water quality criteria
WQS	Water quality standards
WQT	Water quality trading
WRF	Water Reclamation Facility
WSER	Wastewater System Effluent Regulations
WSSC	Washington Suburban Sanitary Commission
WWTF	Wastewater treatment facility
WWTP	Wastewater treatment plant

EXECUTIVE SUMMARY

ES.1 Introduction

This report presents a discussion of nutrient discharge permitting and the variety of potential approaches to establishing effluent limits for nitrogen and phosphorus. An overview of current practices is highlighted, along with a few key issues facing wastewater effluent dischargers. The traditional permit writers' deterministic approach to developing effluent limits is presented in the context of nitrogen and phosphorus. The chapters that follow 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. Depending upon site-specific circumstances, combinations of these approaches to nutrient discharge permitting may provide the best overall way to meet water quality objectives in a cost-effective manner.

Chapter 1.0 presents an introduction to nutrient discharge permitting and key issues for dischargers. An overview of current discharge permitting practices with observations related to nutrient permitting issues is presented in Chapter 2.0. Chapter 3.0 presents the traditional deterministic approach to developing effluent limits. The traditional deterministic approach to discharge permitting is familiar to permit writers and commonly used for water quality-based effluent limits (WQBELs) for many parameters, including nutrients. Deterministic permitting approaches may be overly restrictive in limiting nutrient discharges because they combine conservative assumptions in each aspect of the development of effluent limits: wastewater flow, effluent nutrient concentration, receiving water flow, and ambient water nutrient concentration. Since key reference materials emphasize protection of receiving water quality from toxics, the deterministic approach is very conservative in that it presumes that critical conditions may never be exceeded at the edge of a near field effluent mixing zone in order to protect aquatic life from toxicity. While protection of aquatic life from potential toxicity may warrant this level of conservatism in the development of effluent limits for toxics, it is unnecessary for the control of nutrient discharges associated with enrichment and eutrophication.

Technology-based effluent limitations (TBELs) are discussed in Chapter 4.0 and are intended to prevent pollution by requiring a minimum level of effluent quality that is achieved using treatment technologies for reducing discharges of pollutants to surface waters. There are no federally mandated technology-based standards for nutrients, nor is nutrient removal required as part of secondary treatment standards. Nevertheless, a number of states have used technology-based effluent limits as part of their nutrient management efforts in conjunction with numeric nutrient criteria rulemaking.

The understanding of advanced wastewater treatment for nutrient removal has improved substantially in recent years through operational experience, technology development and research studies, and new efforts to comply with more challenging discharge permits. In Chapter 5.0, technology performance statistics (TPS) are used to describe effluent performance on a statistical basis that can be used to compare the conditions necessary to satisfy receiving water requirements, to define treatment process requirements for facility designers, and to inform discharge permit limits.

The use of predictive water quality models as tools used to estimate future receiving water conditions and develop discharge permits is discussed in Chapter 6.0. Since the purpose of discharge permitting is to limit the pollutants discharged to the receiving water to protect beneficial uses, the information from predictive models can be useful in developing discharge permits. Furthermore, water quality models are tools that can be used to investigate a variety of potentially acceptable discharge permit conditions to find the most technically feasible, economical, and sustainable means of achieving compliance.

Chapter 7.0 presents a probabilistic approach to nutrient discharge permitting allowing the variability in flows and concentrations to be recognized and the most extreme flows and concentrations placed in proper perspective with more typical conditions. A probabilistic approach to nutrient discharge permitting is advantageous because it can utilize a distribution of values for key parameters in the development of effluent limits to portray the variability that exists in effluent and receiving water flows and constituent concentrations.

Watershed-based National Pollutant Discharge Elimination System (NPDES) permitting is a process that emphasizes addressing all stressors within a hydrologically defined drainage basin rather than addressing individual pollutant sources on a discharge-by-discharge basis. Chapter 8.0 presents a series of case study examples where watershed-based approaches to discharge permitting have been applied successfully. Watershed-based permitting can encompass a variety of activities, ranging from synchronizing permits within a basin to developing water quality-based effluent limits using a multiple discharger modeling analysis. The type of permitting activity varies with the ultimate goal of developing permits that better protect entire watersheds.

Chapter 9.0 presents a group of special topics which have an influence on nutrient discharge permitting. The topics include the bioavailability of nitrogen and phosphorus, nutrient offsets and water quality trading, filtered and unfiltered effluent, anti-degradation, and anti-backsliding. Each of these topics may be important considerations in nutrient discharge permitting and may influence the structure of NPDES permits and effluent limits. These subjects are likely to require an additional effort beyond simple NPDES permit renewals in order to include their potential benefits in discharge permitting.

Chapter 10.0 presents conclusions from the discussion of traditional approaches to effluent nutrient discharge permitting, as well as more innovative approaches that incorporate treatment technology performance statistics, predictive water quality models, and probabilistic approaches. 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.

Four appendices complete the report. Appendix A is a summary table of state nutrient criteria and nutrient discharge permits. Appendices B and C provide background information on the status of state numeric nutrient criteria development and key nutrient discharge permits for reference. Appendix D is a permit writers' workshop curriculum for nutrient discharge permitting.

CHAPTER 1.0

INTRODUCTION

Excessive nitrogen and phosphorus loadings to watersheds impact water quality by stimulating the growth of algae which may result in depletion of dissolved oxygen, shifts in pH, degradation of habitat, impairment of drinking water sources, and in some cases harmful algal blooms. According to the EPA, nearly every State has nutrient related pollution with impacts in over 80 estuaries/bays, and thousands of rivers, streams, and lakes. In particular, EPA cites the Gulf of Mexico and the Chesapeake Bay as examples of significant water quality impacts from 35 states that contribute to nutrient loadings.

Nutrient loadings from both point and nonpoint sources contribute to water quality impairments in the nation's waterways. The challenges of assessing the impact of wastewater discharges on receiving waters are common to many of the constituents present in wastewater. The focus here is on nutrients, specifically nitrogen and phosphorus. Nutrients are of concern because at high concentrations, nutrients can result in excessive and nuisance biological growth, such as algae, which may potentially lead to low dissolved oxygen conditions and the overall impairment of the receiving water. Point source discharges from wastewater treatment plants can be a significant source of nitrogen and phosphorus in watersheds. Nonpoint sources contribute substantial amounts of nutrients from land use activities such as agriculture, forestry, and urban/suburban development.

Nitrogen and phosphorus can be subdivided into compounds. Nitrogen compounds are represented as organic nitrogen, ammonia, nitrate, and nitrite. Phosphorus compounds are represented as organic phosphorus and dissolved phosphorus. These compounds may be further defined as labile or refractory. Some of these compounds, including ammonia and nitrite/nitrate can be both plant nutrients and toxic to aquatic species.

Targeted nutrient levels in lakes, streams, and estuaries can be very low concentrations that are challenging to meet with treatment of point sources and application of best management practices (BMPs) to nonpoint sources. 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. Nevertheless, 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.

1.1 Nutrient Discharge Permitting

Surface water nutrient discharges should receive special considerations in discharge permitting for distinction from other effluent parameters, in particular toxic parameters, upon which much of the existing EPA permit writer's guidance is based. Appropriate NPDES discharge permit structures for nutrients can be protective of surface water quality and also be based on long averaging periods, such as seasonal limits based on mean or median statistics. It is important that consideration be given to variability and reliability of effluent performance from advanced nutrient removal facilities because these technologies are highly effective in nutrient removal despite their inherent variability in effluent quality, particularly at low phosphorus and nitrogen concentrations.

Appropriate NPDES permit structures for nutrients will avoid the creation of frameworks that result in compliance issues that are immaterial to surface water quality protection, such as maximum daily and maximum weekly limits, overly restrictive receiving water streamflow assumptions, and the assumption of extreme and improbable coincident events, such as statistical extremes occurring in both receiving waters and effluent discharge quality. Over specifying nutrient permit limits beyond the capabilities of treatment technology will not result in improved water quality, but may result in permit compliance issues for wastewater utilities.

1.2 Attainable and Protective Discharge Permits

In order to develop attainable and protective permits for effluent nutrient discharges, a distinction should be made from biochemical oxygen demand (BOD), ammonia nitrogen, and some toxic pollutants that can have acute effects in the aquatic environment. Appropriate NPDES permitting frameworks will avoid compliance issues that are immaterial to surface water quality protection.

1.2.1 Nutrient Discharge Permit Structures

The appropriate averaging period for nutrient discharges depends on the sensitivity of the waterbody to water quality degradation and where the discharge is in the watershed. EPA's NPDES Permit Writer's Manual (U.S. EPA, 1996a) states that for municipal wastewater treatment plants, permit limits should be expressed in average monthly and average weekly limits. Maximum daily limits can be used for toxics in order to capture acute toxicity criteria.

In general, averaging periods for nutrient discharges can be longer due to slower responses between discharge and water quality degradation. For larger waterbodies, such as bays, sounds, estuaries, and lakes, a monthly or yearly averaging period is more appropriate. In some cases, weekly average nutrient discharges are appropriate. Daily discharges are rarely appropriate given the lack of response in degraded water quality over the course of a single day for nutrient discharges.

1.2.2 Translation of Numeric Nutrient Endpoints to Effluent Discharge Permits

Water quality (TMDL) and permitting NPDES programs are often administered by separate staff groups within state regulatory agencies and communication about the intent of water quality endpoints and the specifics required for the preparation of an NPDES permit are essential. The permitting authority is responsible for interpreting the water quality standards and TMDLs to develop the effluent limitations for the discharge. Their responsibility includes providing sufficient documentation in the administrative record to show how the NPDES permit requirements were developed and how compliance with those requirements will achieve the applicable water quality standards. Since NPDES permit writers may not be involved with the development of water quality standards, such as numeric nutrient endpoints, there is the potential for a lack of understanding of the underlying water quality issues associated with the intended protection of beneficial uses.

1.2.3 Appropriate Averaging Periods for Nutrient Limits

Appropriate NPDES discharge permit structures for nutrients should include long averaging periods, such as annual or seasonal limits based on total loading over long periods or annual or seasonal averages. Consideration should be given to variability and reliability in both the receiving waters and in the effluent performance from wastewater treatment systems.

Unlike toxics and conventional parameters that have a direct and immediate impact on water quality, nutrients have no direct or immediate impact and must be processed in the aquatic environment in order to have an impact. Nutrient assimilation and processing delays and buffers the time between the discharge and the receiving water effect.

1.2.4 Maximum Day and Maximum Week Issues for POTWS

Effluent discharge permit structures should avoid the creation of frameworks that result in compliance issues that are immaterial to surface water quality protection, such as maximum daily and maximum weekly limits, overly restrictive receiving water flow assumptions, and the assumption of extreme and improbable coincident events, such as statistical extremes in both receiving waters and effluent discharge quality. Maximum weekly and maximum daily effluent limits for nutrients are overly restrictive and unnecessary to protect water quality from nutrient effects. Waterbody responses to nutrients occur over longer periods of time associated with the growth and decay of algae, eutrophication and hypoxia that may impair beneficial uses, deplete dissolved oxygen, or result in fish kills.

1.2.5 Effluent Mixing Zones

The use of mixing zones and dilution appears to have questionable applicability to watershed impacts from nutrients since the effects of nutrients tend to be cumulative and caused by mass loadings rather than toxic effects associated with effluent concentration. Mixing zones and dilution may be useful in instances where maximum daily effluent limits (MDELs) and average monthly effluent limits (AMELs) are imposed and compliance may be difficult but, as noted above, these short-term limitations for nutrients are impracticable and unnecessary in most situations involving nutrients.

1.2.6 Impaired Ambient Conditions

Impaired ambient water quality can create difficult situations for effluent discharge permitting since any additional contribution of nutrients may compound receiving water conditions and no cleaner water is available for dilution. By definition, impaired waterbodies that are 303(d) listed and require a TMDL may not have assimilative capacity to receive additional loadings. In some waterbodies, this has led to the waterbody nitrogen and phosphorus target concentrations being applied at the end-of-pipe for effluent discharges. The result may be effluent limits that are below the limits of treatment technology.

1.2.7 Permit Requirements Beyond the Capability of Treatment Technology

The NPDES permitting regulations require that discharge permits include specific pollutant limitations. These discharge limits are initially set based on applicable treatment technology standards dependent upon the specific pollutant or parameter, type of discharge or industry in the case of effluent guidelines. These technology-based limits are then evaluated to determine if the allowable discharges will comply with the receiving water quality requirements. If not, more restrictive limitations are to be established that are water quality-based. However, these WQBELs may represent levels that are beyond the capability of economically available treatment technology. It is not clear that nutrient removal technologies are able to consistently treat to such low concentrations.

1.2.8 Advanced Treatment and Nutrient Speciation

Appropriate consideration should be given to effluent discharge permitting regarding emerging areas of advanced scientific understanding of the effect of advanced nutrient removal treatment on both nutrient speciation and bioavailability. At the boundaries of the current understanding of science is investigation of nitrogen and phosphorus remaining after advanced treatment that may not be removable with current treatment technology. Nitrogen and phosphorus speciation are also important areas of nutrient research, both in terms of biodegradability in wastewater treatment and bioavailability in the water environment.

1.2.9 Changes in Effluent Speciation and Reduced Bioavailability

Advanced levels of nutrient removal treatment impact effluent quality in multiple ways. First, effluent nitrogen and phosphorus concentrations are reduced. Second, nitrogen and phosphorus speciation is altered as a result of the advanced treatment processes. Third, the bioavailability the remaining effluent nitrogen and phosphorus is reduced.

After advanced nutrient removal treatment, the remaining nitrogen and phosphorus in treatment plant discharges may not be removable with current treatment technology. Nitrogen and phosphorus speciation is an important area of nutrient research, both in terms of biodegradability in wastewater treatment and bioavailability in the water environment.

1.3 Innovative Nutrient Permit Approaches

Nationally, there are a variety of successful discharge permit structures for nutrients that have been employed to meet receiving water quality requirements. Technology-based effluent limits for nutrients have been used in several states as a part of numeric nutrient criteria rulemaking. Use of technology-based effluent limits may be a placeholder as an interim step towards future water quality-based effluent limits. Further step limits may be considered as an option when nutrient impacts and point source links to impacts are clear and reductions in point source loads will actually result in designated use improvements. More sophisticated approaches to developing water quality-based effluent limits provide advantages over the traditional deterministic approach. These approaches include predictive water quality modeling, probabilistic modeling, and the use of technology performance statistics. While these approaches may require greater effort in the development of nutrient permits, this investment may well be warranted considering the level of investment for advanced nutrient removal treatment.

1.3.1 Creative Approaches to State Nutrient Standards and Nutrient Discharge Permitting

There are several challenges involved in developing numeric nutrient criteria and appropriate frameworks for discharge permitting. These include the complex relationship between nutrient discharges and water quality responses, and the lack of a common understanding between regulatory agencies and wastewater utilities of the capabilities and limitations of treatment technology. The combination results in the need for new approaches to the translation of numeric nutrient endpoints to discharge permit limits, especially at the lowest, most challenging effluent levels. At the lowest effluent levels, the structure of the discharge permit itself may determine whether or not compliance is feasible.

Fostering a constructive dialog between regulatory agencies, wastewater utilities, and other stakeholders has been found to be effective in bridging some of the gaps in the understanding of potential nutrient requirements and treatment technology capabilities. Technology transfer workshops, regulatory agency briefings, and discussions of implementation guidance for discharge permitting have all been effective in other locations at improving the potential for technically feasible and economically affordable outcomes. Since comprehensive national guidance from EPA that links the development of numeric nutrient endpoints with implementation guidance for effluent discharge permitting for nutrients is not available, individual states have undertaken efforts to develop unique state approaches.

The development of numeric nutrient standards in Wisconsin, Colorado, and Montana has been accompanied by the consideration of implementation guidance for nutrient discharge permitting. In these states, diverse groups of stakeholders have participated in collaborative nutrient workgroups to craft both nutrient standards and implementation guidelines. An important driver in the dialog in these states has been the recognition of the potential for water quality standard rulemaking to result in infeasible effluent limits. That understanding of the gap between what may be required of new numeric nutrient standards, and the capabilities of wastewater facilities to comply with those standards, has led to unique regulatory solutions. While each of these states has undertaken a unique process shaped by state-specific considerations of water quality, there are some commonalities. In each state, questions have been raised about the adequacy of water quality data and the cause and effect relationship between nutrients and beneficial uses. The cost of wastewater treatment to meet new nutrient standards has been a topic of discussion, as have watershed loadings and nonpoint sources, adaptive management approaches, and compliance schedules for meeting new standards. Oversight from EPA and conformance with federal regulations has also entered into the dialog in these states.

1.4 EPA Nutrient Permit Guidance

Section 402 of the Clean Water Act (CWA) specifically required EPA to develop and implement the NPDES program. NPDES permits include effluent limitations for Publicly Owned Treatment Works (POTWs). The CWA authorizes the permit writer "*to use his or her best professional judgment (BPJ) to establish case-by-case limitations*" (U.S. EPA, 2010b). The permit writer is to use his or her knowledge of the industry, the specific discharge, and the receiving water, to develop effluent limitations specific to the facility. Thus, "*the limitations and conditions in NPDES individual permits are unique to each permittee*" (U.S. EPA, 2010b).

The permit writer sets the effluent limitations after evaluating TBELs and WQBELs. The WQBELs are meant to be protective of state water quality standards and incorporate wasteload allocations (WLAs) assigned in an approved TMDL for the receiving water, that are consistent with the assumptions and requirements. However, the permit writer is faced with the challenge of translating between water quality criteria usually expressed in terms of magnitude, duration, and frequency into effluent limitations usually expressed in terms of magnitude and averaging period (U.S. EPA, 2013b).

1.4.1 NPDES Permit Writers' Manual Guidance on Nutrients

The permit writers' manual from EPA provides little specific guidance on the unique aspects of developing nutrient discharge permits. Discharge permitting has evolved from the initial focus on control of discharges of conventional pollutants, (biochemical oxygen demand, total suspended solids, pH, fecal coliform, and oil and grease). This was followed by controlling the discharge of toxic pollutants, also referred to as priority pollutants. Since these pollutants were the focus, the permit writers' manual provides guidance specifically for these pollutants. Nonconventional pollutants followed later with more recent importance on nutrient impacts on water quality.

Given the recent emphasis on nutrients and the challenges of not being derived from toxicity testing in the laboratory, the permit writers' manual does not provide the same depth and breadth of guidance to the permit writer for nutrients. The guidance to the permit writer is to look for locally applicable requirements, be protective of the environment, and select the appropriate duration and frequency (U.S. EPA, 2010b). The permit writer is left to determine limitations locally as there are not nationally applicable criteria and these local limits can be refined using nutrient criteria technical guidance manuals. The permit writer must determine the limitations that are protective of conditions of surface waters that have minimal impacts caused by human activities.

1.4.2 NPDES Permit Writers' Conference

EPA conducted a National NPDES Permit Writers Conference in Shepherdstown, WV on July 25, 2013. Presentations at this conference included the following:

- ♦ CWA-SDWA Collaboration.
- ♦ Improving Clarity of NPDES General Permits.
- ♦ TMDL-to-Permits Process: Common Problems and Solutions.
- ♦ Technology-based Effluent Limitations for Publicly Owned Treatment Works (POTWs).
- ♦ Establishing Water Quality-based Effluent Limitations in NPDES Permits: Part III-Determine the Need for WQBELs.
- ♦ Establishing Water Quality-based Effluent Limitations in NPDES Permits: Part IV-Calculate Chemical-specific WQBELs and Determine Final Effluent Limitations.
- ♦ Climate Change, Water Quality and NPDES.
- ♦ Overview of MS4 Program: Post Construction Standards for New Development and Redevelopment.
- ♦ Whole Effluent Toxicity Implementation in ICIS-NPDES.

The topics of presentations related to nutrients were as follows (U.S. EPA, 2013b):

- ♦ NPDES Permit Writer's Specialty Workshop: Developing WQBELs for Nutrient Pollution.
- ♦ WQBELs for Nutrients: Identify the Applicable Water Quality Standards – Module 1.
- ♦ WQBELs for Nutrients: Determine the Need for WQBELs – Module 2.

- WQBELs for Nutrients: Calculate WQBELs – Module 3.
- WQBELs for Nutrients: Determine Final Effluent Limitation and Additional Considerations – Module 4.

The disclaimer to the nutrient presentations states that the intent was to provide senior state NPDES permit writers with a preview of a specialty course on permitting for nutrient pollution that EPA is working on developing (U.S. EPA, 2013b). This "pilot" was given so that EPA could receive comments from conference participants and noted that EPA continues to refine the content in this training based on comments. The disclaimer notes that the information presented supplements, and does not modify, existing U.S. EPA policy, guidance, and training on NPDES permitting.

The introductory presentation on nutrient WQBELs summarizes nutrient pollution impacts on water quality. The module on applicable water quality standards covers identification of nutrient related water quality criteria. This includes state numeric nutrient criteria for nitrogen and phosphorus. The second module on determination of the need for WQBELs addresses qualitative and quantitative reasonable potential analysis, interpretation of narrative and numeric nutrient criteria, EPA ecoregional nutrient criteria, and effluent mixing zone considerations. The basic steady state receiving water mass balance equation is covered, as are the identification of the names of some water quality models. The EPA Technical Support Document (U.S. EPA, 1991) is referenced for selection of the critical effluent concentration and the recommendation is to set a single critical value at the 95th or 99th percentile concentration. The third module calculates effluent limits based on a wasteload allocation from a TMDL. The materials distinguish nutrients from the EPA Technical Support Document approach for toxics. Average monthly limits are recommended to be set at the wasteload allocation and average weekly limits calculated as the 99th percentile of lognormal statistics. The fourth module on final effluent limits notes that permits must meet antidegradation and anti-backsliding requirements.

1.5 Model Nutrient Permitting

Although receiving water quality requirements vary depending upon location and permit writers are to use their best professional judgment to establish case-by-case effluent limitations for water quality-based effluent limitations, it is important that permits be technically attainable and flexible. Permits should be attainable from the standpoint of treatment performance for successful compliance. Flexible in terms of fostering opportunities for effective effluent management, trading, water quality offsets, effluent recycling and reuse, etc. to improve water quality and meet nutrient discharge limitations.

1.5.1 Attainable Permits

WERF's Nutrient Removal Challenge research has provided detailed information about nutrient removal performance at key full-scale facilities that informs both utilities and regulators about the effectiveness, variability, and reliability of treatment technology with performance statistics. TPS have been used to describe process performance. In this approach, the treatment plant or technology performance is tied to the statistical rank to express the probability of achieving a certain performance.

For permit compliance a utility can use the performance statistics to determine the reliability required to meet their treatment goals in terms of the operator proficiency, process performance, and acceptance of risk. EPA recommends the use of the 95th percentile probability basis (5 percent exceedance probability) for the average monthly limit in permitting (U.S. EPA, 1991). Reliable nutrient removal process performance is represented by the 95th percentile statistic which on a monthly basis is exceeded three times in a five-year period (three months out of 60 months or 5% of the time).

Permit structures should be based upon nutrient removal facility characteristics and not statistical relationships based upon other parameters or guidance based on toxics. Operational data from full scale facilities demonstrate the variability observed in advanced nutrient removal facilities. Permit structures that incorporate treatment and performance variability for nutrient removal will provide an avenue to avoid overdesigning facilities to accommodate the worst case scenario under all operating conditions.

1.5.2 Permit Flexibility

Given the range of options available to the permit writer, it is important to consider the advantages and disadvantages to both the wastewater utility and the receiving water environment when developing nutrient discharge permits. This includes the development of permit structures for effluent limitations, such as concentration and/or mass limits, averaging period and duration, seasonality, and so on.

A wide variety of nutrient permit structures have been utilized across the country and flexibility is available for permit writers to prepare permits for successful compliance with attainable treatment technology. WERF's Nutrient Removal Challenge research has provided detailed information about nutrient removal performance at key full-scale facilities that informs both utilities and regulators about the effectiveness, variability, and reliability of treatment technology with performance statistics.

Finding the best combination of advanced treatment for nutrient removal and other watershed management practices presents a challenge for utility managers and regulators. Understanding the technically achievable and cost effective levels of advanced wastewater treatment is an important goal of the WERF Nutrient Removal Challenge research to help balance these competing demands. Nutrient permit structures that provide utilities with flexibility foster creative solutions to best meet overall water quality objectives, such as watershed permitting, shared loading capacity, and trading. Flexible permits can be developed to facilitate opportunities for effluent reuse, recharge, and restoration.

CHAPTER 2.0

CURRENT PERMITTING PRACTICES

This chapter presents an overview of current discharge permitting practices with observations related to nutrient permitting issues. Most of the source material for the information in this chapter originates from the EPA permit writers' manual (U.S. EPA, 2010b). Nutrient issues are emphasized where appropriate and a few important NPDES topics pertaining to nutrients are then addressed. These include averaging periods, interim limits, compliance schedules, and impracticable determinations.

The traditional deterministic approach to developing effluent nutrient limitations is discussed in greater detail in Chapter 3.0. Chapter 4.0 addresses technology-based effluent limits, followed by technology performance statistics in Chapter 5.0, predictive water quality models in Chapter 6.0, and probabilistic permitting in Chapter 7.0.

2.1 Overview of Current Practices

Development of effluent limits typically consists of three initial technical steps: 1) development of TBELs, 2) development of WQBELs, and 3) determination of final effluent limitations and conduct of an anti-backsliding analysis.

2.1.1 Technology-Based Effluent Limitations

The CWA establishes TBELs for three basic water quality parameters with respect to POTWs secondary treatment standards: BOD, total suspended solids (TSS), and pH. Presently there are no existing national TBELs for nutrients, although several states are using this approach for nutrient limits (see Chapter 4.0). Note that TBELs are developed independently of the potential impact of a discharge on the receiving water, which is addressed through water quality standards and WQBELs (U.S. EPA, 2010b).

2.1.2 Water Quality-Based Effluent Limitations

Since national TBELs do not exist for nutrients, the permit writer derives effluent limitations that are protective of state water quality standards (i.e., WQBELs) as needed. The process of translating water quality standards to water quality-based effluent limits consists of determining the applicable standards, characterizing the effluent and receiving waters, determining the need for limits, and finally calculating the limits.

2.1.2.1 Determine Applicable Water Quality Standards

Water quality standards are made up of designated uses, water quality criteria, and antidegradation policy. The expected uses of waterbodies in a state are called designated uses. In § 131.10(a) the regulations describe the various designated uses that must be considered when establishing water quality standards (WQS). Examples include public water supplies, agricultural, fish and wildlife, industrial, and recreation. More specific uses (e.g., warm water fisheries) can also be established by states.

EPA's WQS Regulation at § 131.11(a) requires states to adopt water quality criteria (WQC) using sound scientific rationale and to include sufficient parameters or constituents to protect the designated use (U.S. EPA, 2010b). If a waterbody has multiple use designations, the criteria must support the most sensitive use. Numeric water quality criteria are developed for specific parameters to protect aquatic life and human health and, in some cases, wildlife from the deleterious effects of pollutants.

States are also allowed to adopt both numeric and narrative water quality criteria. Narrative criteria describe the desired water quality goals for a waterbody. States establish narrative criteria where numeric criteria cannot be established, or to supplement numeric criteria. As an example, narrative criteria may state that waters must be "free of objectionable color, odor, taste, and turbidity."

EPA has developed recommendations for nutrients that are numeric values for both causative (phosphorus and nitrogen) and response (chlorophyll a and turbidity) variables associated with the assessment and prevention of eutrophic conditions (U.S. EPA, 2010a). EPA's recommended nutrient criteria are different from most of its other recommended criteria. In contrast with the criteria for constituents that have toxic effects, such as ammonia, EPA's recommended nutrient criteria differ for the following reasons:

- EPA's recommended nutrient criteria are *ecoregional* rather than nationally applicable criteria, and they can be refined and localized using nutrient criteria technical guidance manuals.
- The recommended nutrient criteria represent conditions of surface waters that have minimal impacts caused by human activities rather than values derived from laboratory toxicity testing.
- The recommended nutrient criteria do not include specific duration or frequency components; however, the ecoregional nutrient criteria documents indicate that states may adopt seasonal or annual averaging periods for nutrient criteria instead of the one-hour, 24-hour, or four-day average durations typical of aquatic life criteria for toxic pollutants.

The ecoregional nutrient criteria documents, technical guidance manuals, and other information on EPA's nutrient criteria recommendations, are available at:
http://www2.epa.gov/nutrient-policy-data/ecoregional-criteria-documents.

Nutrient criteria have been established by some states and adopted as water quality standards. Some states have followed EPA's reference criteria approach, customized that approach to state specific conditions, or linked nutrient criteria to stressor-response relationships to protect beneficial uses such aquatic life, recreation, etc.

2.1.2.2 Antidegradation Review

Early in the permit development process, a permit writer is to check the state's antidegradation policy and implementation methods to determine what tier(s) of protection, if any, the state has assigned to the proposed receiving water for the parameter(s) of concern (U.S. EPA, 2010b). The tier of antidegradation protection is important for determining the required process for developing the water quality-based permit limits and conditions. After identifying the tier(s) of protection for the proposed receiving waterbody and parameter(s) of concern, the permit writer should consult the state's antidegradation implementation procedures relevant to the tier(s).

A state's antidegradation policy specifies the framework to be used in making decisions about proposed activities that will result in changes in water quality (U.S. EPA, 2010b). Antidegradation policies can play a critical role in helping states protect the public resource of water whose quality is better than established criteria levels and ensure that decisions to allow reductions in water quality are made in a public manner and serve the public good. Along with developing an antidegradation policy, each state must identify the method it will use to implement the policy. A state's antidegradation policy provides three levels of protection from degradation of existing water quality:

- **Tier 1:** Existing uses and the associated level of water quality are to be maintained and protected.
- **Tier 2:** Where the quality of waters exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation (sometimes referred to as *high-quality waters*), this level of water quality is to be maintained and protected (although there are cases where exceptions can be made [EPA, 2010b]).
- **Tier 3:** Outstanding national resources waters (ONRWs) must be maintained and protected.

States take a variety of approaches to implementing antidegradation policies (U.S. EPA, 2010b). Some states designate their waters as Tier 1, Tier 2 (high-quality water), or Tier 3 waters in their antidegradation implementation methods, while others designate a waterbody as a Tier 2 or high-quality water only when activities that would degrade water quality are proposed. In some cases, states may have classified the waterbody as receiving a tier of protection for all pollutant-related parameters, whereas in other cases, tiers of protection have been determined on a parameter-by-parameter basis.

Chapter 9.0 Special Topics in Nutrient Permitting explores antidegradation in greater detail as it relates to situations involving nutrients.

2.1.2.3 Characterize the Effluent and the Receiving Water

A permit writer typically characterizes both the effluent and the receiving water following five steps: 1) identify pollutants of concern in the effluent; 2) determine whether water quality standards provide for consideration of a dilution allowance or mixing zone; 3) select an approach to model effluent and receiving water interactions; 4) identify effluent and receiving water critical conditions; and 5) establish an appropriate dilution allowance or mixing zone (U.S. EPA, 2010b).

2.1.2.4 Determine the Need for Water Quality-Based Limits

Reasonable potential analysis (RPA) is the approach used to determine whether a discharge may cause receiving water quality standards to be exceeded. The federal regulations at § 122.44(d)(1)(i) state, *"Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which the Director determines are or may be discharged at a level that will cause, have the reasonable potential to cause, or contribute to an excursion above any [s]tate water quality standard, including [s]tate narrative criteria for water* *quality*." Reasonable potential analysis is to apply to numeric and narrative water quality standards.

Chapter 3.0 presents a more detailed discussion of reasonable potential analysis for nutrients.

2.1.2.5 Calculation of Water Quality-Based Limits

If it is determined that a discharge has reasonable potential to cause, or contribute to an excursion above any state water quality standard, the permit writer must develop WQBELs for that pollutant parameter (U.S. EPA, 2010b). Calculation of WQBELs for toxic (priority) pollutants, and for a number of conventional or nonconventional pollutants with effluent concentrations that tend to follow a lognormal distribution, often use the EPA reference document "Technical Support Document for Water Quality-based Toxics Control" (U.S. EPA, 1991) as guidance. Wastewater treatment plant effluent nutrient data are generally considered to be log-normally distributed.

Chapter 3.0 presents a more detailed discussion of the calculation of water quality-based effluent limits nutrients.

2.1.2.6 Reasonable Potential Analysis and WQBELs for Toxicity

Whole Effluent Toxicity (WET) tests are bioassay toxicity tests and can be used as a second approach to the development of WQBELs. WET testing does not apply to nutrients because they are not considered toxins, with the exception of the ammonia species of nitrogen, which is toxic to aquatic life. Ammonia criteria and the development of effluent limits based on control of ammonia toxicity is not addressed in this volume.

2.1.3 Determine Final Effluent Limitations and Conduct Anti-Backsliding Analysis

The permit writer determines the limitations (e.g., TBELSs, WQBELs) that ensure that all CWA standards are met. For reissued permits, if any of the limitations are less stringent than limitations on the same pollutant in the previous NPDES permit, the permit writer then conducts an anti-backsliding analysis and, if necessary, revises the limitations accordingly. In general, the term anti-backsliding refers to statutory and regulatory provisions that prohibit the renewal, reissuance, or modification of an existing NPDES permit that contains effluent limitations, permit conditions, or standards less stringent than those established in the previous permit (U.S. EPA, 2010b). There are, however, exceptions to the prohibition, and determining the applicability and circumstances of the exceptions requires familiarity with both the statutory and regulatory provisions that address anti-backsliding.

Anti-backsliding issues that have arisen in nutrient permitting are discussed in greater detail in Chapter 9.0 Special Topics in Nutrient Permitting. An important distinction related to nutrient permitting is that anti-backsliding refers to the renewal of discharge permits with effluent limits that are less stringent, as opposed to historical effluent performance.

2.2 Specific Nutrient Permit Issues

Several issues pertaining to permitting issues with respect to nutrients were discussed in WERF, 2010, including TMDLs, appropriate averaging periods, mixing zones, impaired ambient conditions, and permit requirements beyond the capability of treatment technology. Four key nutrient permitting issues are discussed in greater detail in the following sections.

2.2.1 Monthly and Weekly Limits

Effluent limits are often expressed on either a daily, weekly, or monthly basis. As stated earlier, establishment of parameter-specific WQBELs has often utilized the approaches set forth in EPA (U.S. EPA, 1991), which is focused on toxins. EPA states:

Two types of permit limits are contained in the effluent guidelines regulations: daily maximum limits and monthly average limits. The daily maximum permit limit is the maximum allowable value for any daily sample. The daily maximum limits are usually based on the 99th percentile of the distribution of daily measurements. The monthly average permit limit is the maximum allowable value for the average of all daily samples obtained during one month. Monthly average limits are in most cases based on the 95th percentile of the distribution of averages of daily values.

Permit calculations assume that effluent data are log-normally distributed, which may often be the case. EPA (U.S. EPA, 1991) argues that the lognormal probabilistic dilution model has advantages (can predict the frequency and duration of toxicant concentrations in riverine environments; does not require time series data; can incorporate the cross-correlation and interaction of time-varying pH, flow, temperature, pollutant discharges, and other parameters if the analysis is developed separately for each season and the results are combined) and disadvantages (requires more input than a steady-state model; does not include instream fate processes; applies only to rivers and streams; analyzes multiple pollutant sources inaccurately; requires model input data to be log-normally distributed).

Statistical characteristics of effluent discharged from wastewater nutrient removal facilities is the focus of Chapter 5.0 Technology Performance Statistics and Permitting. Application of probabilistic approaches to nutrient discharge permitting is discussed in greater detail in Chapter 7.0 Probabilistic Approaches to Nutrient Permitting.

2.2.2 Compliance Schedules

The NPDES regulations at § 122.47 allow permit writers to establish schedules of compliance to give permittees additional time to achieve compliance with the CWA and applicable regulations (U.S. EPA, 2010b). Schedules developed under this provision must require compliance by the permittee as soon as possible, but may not extend the date for final compliance beyond compliance dates established by the CWA. Thus, compliance schedules in permits are not appropriate for every type of permit requirement. Specifically, a permit writer may not establish a compliance schedule in a permit for TBELs because the statutory deadlines for meeting technology standards (i.e., secondary treatment standards and effluent guidelines) have passed. This restriction applies to both existing and new dischargers. Permit writers should note, however, that § 122.29(d)(4) allows a new source or new discharger up to 90 days to start-up its pollution control equipment and achieve compliance with its permit conditions (i.e., provides for up to a 90-day period to achieve compliance).

Examples of requirements for which a compliance schedule in an NPDES permit might be appropriate include:

- ♦ Pretreatment program development.

- Sludge use and disposal program development and implementation.
- Best Management Plan (BMP) plan development and implementation.
- Effluent limitations derived from new or revised water quality standards.

In May 2007, the Director of EPA's Office of Wastewater Management issued a memorandum to EPA Region 9 that clarified the requirements of § 122.47 as they relate to WQBELs (Hanlon, 2007). Permit writers should consider the principles outlined in this memorandum when assessing whether a compliance schedule for achieving a WQBEL is consistent with the CWA and its implementing regulations and when documenting the basis for a compliance schedule in a permit. Considerations outlined in the memo include the following:

- Demonstrate that the permittee cannot immediately comply with the new effluent limitation on the effective date of the permit.
- Include an enforceable final effluent limitation and a date for achievement in the permit.
- Justify and document the appropriateness of the compliance schedule; factors relevant to a determination that a compliance schedule is appropriate include how much time the discharger had to meet the WQBEL under prior permit(s), whether there is any need for modifications to treatment facilities, operations, or other measures and, if so, how long it would take to implement such modifications.
- Justify and demonstrate that compliance with the final WQBEL is required as soon as possible; factors relevant to a determination that a compliance is required as soon as possible include the steps needed to modify or install treatment facilities, operations, or other measures and the time those steps would take.
- Include an enforceable sequence of events leading to compliance with interim milestones for schedules longer than one year.
- Recognize that a schedule solely to provide time to develop a TMDL or to conduct a use attainability analysis Use Attainability Analysis (UAA) is not appropriate.

Many of the principles outlined in the memorandum could be more generally applied to compliance schedules for requirements other than WQBELs (U.S. EPA, 2010b).

An important consideration related to the use of compliance schedules in nutrient discharge permitting is that the underlying presumption is that water quality-based effluent limits will eventually be achieved by the treatment facility at the conclusion of the compliance schedule. It should be noted that in some cases, water quality-based effluent limits based on numeric nutrient criteria that are very low concentrations may not be technically feasible. In these cases, compliance schedules may not be the appropriate regulatory implementation tool to address infeasibility. It may be necessary to consider alternative regulatory approaches such as site-specific criteria, variances, or use attainability analysis.

2.2.3 Interim Limits

Situations may arise where compliance with final effluent limits are not immediately possible. In such instances interim effluent limits may be considered. While federal regulations state that any interim effluent limits need to be at least as stringent as the final effluent limits in a previous permit (40 C.F.R. 122.44(l)(1)), it is typically left up to the states to determine how to establish interim effluent limits.

The State of Washington (2011) permit writer's manual states that:

"…the interim limits may be based on existing performance and calculated using PERFORMLIM in TSDCALC.XLW."

The "TSDCALC.XLW" file can be found at: http://www.ecy.wa.gov/programs/eap/pwspread.html.

The program uses the 95th percentile for average monthly limits, the 99th percentile for maximum daily limits, and is based on the assumption that the effluent data are log-normally distributed. If the sampling frequency is 10 or more per month, the program switches to a normal distribution for the average monthly limit (based on the Central Limit Theorem).

Other states also provide general guidance with respect to interim limits (e.g., Oregon, 2010).

The State of Wisconsin has specific phosphorus requirements for NPDES permits, with limits based on a mass-balance calculation (Wisconsin DNR, 2011). Dischargers are required to either meet a 1 mg/l total phosphorus limit as a monthly average, or propose an alternative limitation. Wisconsin states:

"An interim effluent limitation and compliance schedule for completing the study shall be imposed in a permit until the request for an exemption from the 1 mg/L effluent standard is approved or denied. The interim effluent limitation shall be equal to the representative concentration of total phosphorus as a monthly average in the effluent based on the information provided by the permittee as a part of the Wisconsin Pollutant Discharge Elimination System (WPDES) permit application process."

Other states have also provided guidance for interim limits with respect to nutrients (e.g., Montana, 2014).

2.2.4 Impracticable Determinations

Average weekly and monthly effluent limits are required for POTWs (40 CFR 122.45(d)), unless "impracticable". Regarding nutrient effluent limits for the Chesapeake Bay, EPA found that annual nutrient permit limits were appropriate because it is impracticable to express limits on a shorter time scale (Hanlon, 2004).

In an example pertaining to an individual municipal wastewater facility, such as the City of Coeur d'Alene wastewater treatment plant, EPA (2013c) determined that:

"…it is impracticable to express the water quality-based effluent limits for TP, ammonia, and Carbonaceous Biochemical Oxygen Demand (CBOD) that are necessary to meet Washington's water quality criteria for dissolved oxygen as monthly average and weekly average limits…… The water quality-based effluent limits for total phosphorus (TP), ammonia and CBOD are expressed as seasonal average loading limits that are identical to the loads of TP simulated in the modeling."

The result of this impracticable determination was that seasonal mass loading limits were used for the phosphorus, ammonia, and CBOD discharges to the Spokane River.

CHAPTER 3.0

DETERMINISTIC PERMITTING

The traditional deterministic approach to developing effluent limitations uses specific effluent conditions (flow and concentration) in combination with specific upstream receiving water conditions (flow and concentration) to calculate the predicted downstream concentration. The traditional deterministic approach to discharge permitting is familiar to permit writers and commonly used for WQBELs for many parameters, including nutrients. Much of the guidance material used by permit writers for reference is focused on the deterministic approach. Since key reference materials emphasize protection of receiving water quality from toxics, the deterministic approach is very conservative, in that it presumes that critical conditions may never be exceeded within and at the edge of a near field effluent mixing zone in order to protect aquatic life from acute and chronic toxicity. Less reference material is available to permit writers as guidance for the development of effluent nutrient limits where broader watershed impacts, such as eutrophication, are the predominant objective for controlling nutrient discharges. Deterministic permitting may be unnecessarily restrictive because it is based upon a combination of critical conditions that are unlikely to coincide. While protection of aquatic life from potential toxicity may warrant this level of conservatism in the development of effluent limits for toxics, it is unnecessary for the control of nutrient discharges associated with enrichment and eutrophication.

This chapter explores the traditional permit writers approach to deterministic permitting as applied to the development of nutrient effluent limits. The chapters that follow address technology-based effluent limits (Chapter 4.0), technology performance statistics (Chapter 5.0), predictive water quality models (Chapter 6.0) and probabilistic permitting (Chapter 7.0).

3.1 Deterministic Permitting Approach

A deterministic model is one in which outcomes are determined using relationships among the parameters. Deterministic models explicitly represent major physical processes in a system. With a given input, these models will always produce the same output. Accounting for variability is limited with a deterministic model to the selection of extreme values.

The deterministic methodology selects extreme values for effluent and receiving water flows and nutrient concentrations to compute downstream conditions and determine whether there is a potential to exceed water quality standards. If the calculated downstream concentration exceeds the water quality standard or nutrient target, then effluent limitations are required. The approach taken to RPA typically combines the maximum effluent discharge and concentration with the highest observed ambient concentrations during a low receiving water flow condition (e.g., 7Q10 flow). If reasonable potential to cause or contribute to the exceedance of a water quality standard is established, then effluent limits are back calculated from the in-stream target concentration using a similar mass balance approach, again with a selection of conservative values.

Generally, the deterministic approach using the most conservative values results in the calculation of the worst possible mixed downstream receiving water condition. Deterministic permitting approaches may be overly restrictive in limiting nutrient discharges because they combine conservative assumptions in each aspect of the development of effluent limits: wastewater flow, receiving water flow, and ambient water nutrient concentration. It is unlikely that there will be a convergence of the most extreme values for flow and concentration, in both the effluent discharge and the receiving waters, at the same time. That is to say that there is little chance that the highest effluent concentration at maximum wastewater discharge will coincide with the highest receiving water concentration at the lowest receiving water flows.

EPA noted in the Technical Support Document for Water Quality-based Toxics Control Basis (TSD) (U.S. EPA, 1991) that these conditions would occur rarely, or never, and that the deterministic approach would result in permit limits more stringent than necessary:

"Traditional single-value or two-value steady-state WLA models calculate WLAs <u>at critical conditions, which are usually combinations of worst-case assumptions of flow, effluent, and environmental effects</u>. For example, a steady-state model for ammonia considers the maximum effluent discharge to occur on the day of lowest river flow, highest upstream concentration, highest pH, and highest temperature. Each condition by itself has a low probability of occurrence; the combination of conditions <u>may rarely or never occur</u>. Permit limits derived from a steady-state WLA model will be protective of water quality standards at the critical conditions and for all environmental conditions less than critical. <u>However, such permit limits may be more stringent than necessary to meet the return frequency requirements of the water quality criterion for the pollutant of concern.</u>" (U.S. EPA, 1991)

Toxics impact the physiology of aquatic organisms in a harmful way, often on short spatiotemporal scales. The EPA TSD approach acknowledges this causal mechanism, and uses extreme values (e.g., 95^{th} or 99^{th} percentile on a lognormal distribution) to provide assurance that aquatic life is protected with a high degree of confidence. Nutrient impacts on water quality are distinctly different than the impact of toxics. Rather than directly impacting aquatic organisms in a harmful way, nutrients act as a stimulating growth factor, often on longer spatiotemporal scales than are typically seen for toxic compounds. When a permit writer applies this approach to nutrients, the resulting effluent limits are likely to be very low concentrations and perhaps lower than achievable with advanced nutrient removal treatment technology.

3.1.1.1 Benefits

Benefits of the traditional deterministic approach to developing effluent limits for nutrients are summarized as follows:

- Commonly applied approach to water quality-based effluent limits that is familiar to permit writers.

3.1.1.2 Limitations

Limitations of the deterministic approach to developing effluent limits for nutrients are summarized as follows:

- Based on guidance for controlling aquatic toxicity (U.S. EPA, 1991) as opposed to watershed nutrient enrichment.
- Fails to address the uncertainty in the relationship between nutrients and designated uses.
- Creates effluent limits based on receiving water nutrient criteria applied as not to exceed values narrowly to a near field mixing zone.

- Results in overly restrictive effluent nutrient limits based on critical conditions that are unlikely to occur.
- Excludes information about variability in effluent concentrations, treatment efficiency and reliability.
- Excludes temporal and spatial variability of the receiving water, acceptable risks of exceedance of nutrient criteria, and stressor response relationships.

3.2 Deterministic Permit Development

An example of a deterministic model commonly used in permitting is the mass balance equation used to perform the reasonable potential analysis. For the RPA, a comparison is made between the maximum projected receiving water concentration and the water quality criteria for that pollutant. If the projected receiving water concentration exceeds the criteria, there is reasonable potential to exceed a water quality standard and a water quality-based effluent limit is required in the permit.

For discharges to flowing waterbodies, the maximum projected receiving water concentration is determined using a steady state deterministic model represented by the following mass balance equation:

$$C_dQ_d = C_eQ_e + C_uQ_u$$

Where terms are defined as follows:

C_d = Receiving water concentration downstream of the effluent discharge
C_e = Maximum projected effluent concentration
C_u = 95^{th} percentile measured receiving water upstream concentration
Q_d = Receiving water flow rate downstream of the effluent discharge = $Q_e + Q_u$
Q_e = Effluent flow rate (set equal to the design flow of the wastewater facility)
Q_u = Receiving water low flow rate upstream of the discharge (e.g., 1Q10, 7Q10 or 30B3)

The mass balance equation may be rearranged to solve for different parameters. A mixing zone fraction or dilution factor may also be included. The mass balance equation is the combination of masses from two sources and the results are entirely dependent upon the inputs selected by the user.

When the mass balance equation is solved for the downstream concentration (Cd), it becomes:

$$Cd = (CeQe + CuQu) / (Qe + Qu)$$

The above form of the equation is based on the assumption that the discharge is rapidly and completely mixed with the receiving stream and that all of the stream flow is available for mixing. However, water quality standards generally restrict the percentage of the stream flow that may be allowed for dilution of the effluent. When the mixing zone uses less than the entire stream flow, the equation for the downstream concentration (Cd) becomes:

$$Cd = (CeQe + Cu(Qu \times MZ)) / (Qe + (Qu \times MZ))$$

In the above equation, MZ is the fraction of the receiving water flow available for dilution. State water quality standards may limit mixing zones to a percentage of the total flow, such as 25 percent of the volume of the stream flow as is common in some states.

3.2.1 Reasonable Potential Analysis (RPA)

A RPA is used to determine whether a discharge will lead to an excursion above an applicable water quality standard. The federal regulations require effluent limitations to achieve water quality standards in 40 CFR 122.44(d)(1)(i) as follows:

*"**(i)** Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which the Director determines are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality."*

EPA identifies four steps for the permit writer to follow in conducting a reasonable potential analysis (U.S. EPA, 2010):

1. *Determine the Appropriate Water Quality Model.*
    a. *Steady-state or dynamic water quality modeling techniques can be used in effluent discharge permitting.*
2. *Determine the Expected Receiving Water Concentration under Critical Conditions.*
    a. *The permit writer determines the impact of the effluent discharge on the receiving water under critical conditions.*
        i. *The definition of "critical conditions" is important.*
            1) *EPA recommends considering a receiving water concentration that represents something close to the maximum concentration.*
            2) *EPA identifies hydrologically based low flow conditions in rivers and streams as critical conditions for toxics.*
            3) *EPA references the 1991 TSD for the statistical basis for defining critical effluent concentrations.*
3. *Answer the Question, Is There Reasonable Potential?*
    a. *If the receiving water pollutant concentration calculated with the steady-state model exceeds the applicable water quality criterion, there is reasonable potential, and the permit writer must calculate WQBELs.*
4. *Document the Reasonable Potential Determination in the Fact Sheet.*

The EPA permit writers' manual distinguishes between conservative pollutants and parameters those that are non-conservative, such as nutrients, and suggests the use of more sophisticated water quality models (U.S. EPA, 2010b):

"For many pollutants such as most toxic (priority) pollutants, conservative pollutants, and pollutants that can be treated as conservative pollutants when near-field effects are of concern, if there is rapid and complete mixing in a river or stream, the permit writer could use a simple mass-balance equation to model the effluent and receiving water."

"For pollutants such as BOD, nutrients, or non-conservative parameters, the effects of biological activity and reaction chemistry should be modeled, in addition to the effects of dilution, to assess possible impacts on the receiving water. This manual focuses only on dilution of a pollutant discharged to the receiving water and does not address modeling biological activity or reaction chemistry in receiving waters. For additional information, permit writers should discuss modeling that accounts for biological activity or reaction chemistry with water quality modelers or other water quality specialists as needed and consult EPA's Water Quality Models and Tools Website."

EPA references guidance developed for permit writers on how to characterize effluent concentrations of certain types of pollutants using a limited data set and accounting for variability in the 1991 TSD (U.S. EPA, 1991). EPA determined that daily pollutant measurements of many pollutants follow a *lognormal distribution* and the TSD provides procedures to project a critical effluent concentration (e.g., the 99^{th} or 95^{th} percentile of a lognormal distribution of effluent concentrations) from a limited data set using statistical procedures based on the characteristics of the lognormal distribution. These procedures use the number of available effluent data points for the measured concentration of the pollutant and the coefficient of variation (CV) to measure variability.

The EPA permit writer's manual notes that critical conditions for receiving waters are generally specified in state water quality standards that define the duration and frequency of the water quality criteria. EPA states that for most pollutants and criteria, the critical flow in rivers and streams is some measure of the low flow of that river or stream. Examples of typical hydrologically based low flows used in state water quality standards for toxics include the 7Q10 (seven-day average, once in 10 years) low flow for chronic aquatic life criteria, the 1Q10 (1-day average, once in 10 years) low flow for acute aquatic life criteria, and the harmonic mean flow for human health criteria for toxic organic pollutants.

The important conditions for nutrients may not be the same as the critical conditions for controlling toxics. For nutrients, the greatest impacts are likely to occur at conditions different than those critical conditions for toxics. For example, low flows may not result in the great algal densities, and instead a high flow with a greater volume and larger wetted channel may be more favorable for the greatest algal growth. Effluent concentrations may result in algal growth dynamics in the shape of an S-curve or step function. High concentrations may result in little change in algal densities, while moderate concentration reductions provide the greatest response to lessen algae growth, and further reductions may show little to no further reductions in algae. The permit writers' guidance uses extreme values as critical conditions, with statistical extremes to establish the RPA, as opposed to using other values such as seasonal averages related to enrichment driven growth. The cause and effect of the discharge parameter should be understood before applying a deterministic model. For toxics, the highest concentrations near field to the discharge are likely to be the critical condition. For nutrients, a far field concentration over a period of time is more likely to be the critical condition.

3.2.2 Calculating Permit Limits

If a permit writer determines that there is reasonable potential to cause, or contribute to an excursion above a water quality standard, the permit writer must develop WQBELs for that parameter. The EPA permit writers' manual presents the approach recommended in EPA's 1991 TSD for calculating WQBELs for toxics in five steps according to the following (U.S. EPA, 2010b):

1. *Determine Acute and Chronic WLAs.*
    a. *The EPA permit writers' manual outlines the approach to water quality-based effluent limits for aquatic life criteria, which explains the use of the acute and chronic terminology.*
        i. *A WLA may be determined from a TMDL or calculated for an individual point source directly.*
2. *Calculate Long-Term Average (LTA) Concentrations for Each WLA.*

a. *EPA references the procedure discussed in Chapter 5.0 of the 1991 TSD that results in defensible, enforceable, and protective WQBELs.*
   i. *For those pollutants with effluent concentrations that follow a lognormal distribution, the distribution can be described by determining a LTA that ensures that the effluent pollutant concentration remains nearly always below the WLA, and by the CV as a measure of the variability of data.*

3. *Select the Lowest LTA as the Performance Basis for the Permitted Discharger.*
   a. *EPA recommends that the permit writer select the lowest LTA as the basis for calculating effluent limitations because that would ensure that the facility's effluent pollutant concentration remains below all the calculated WLAs nearly all of the time.*
4. *Calculate an Average Monthly Limitation (AML) and a Maximum Daily Limitation (MDL).*
   a. *EPA cites the NPDES regulations at 40 CFR 122.45(d) that require that all effluent limitations be expressed, unless impracticable, as both AMLs and MDLs for all discharges other than POTWs and as both AMLs and WLAs for POTWs.*
      i. *The AML is the highest allowable value for the average of daily discharges over a calendar month.*
      ii. *The MDL is the highest allowable daily discharge measured during a calendar day or 24-hour period representing a calendar day.*
      iii. *The WLA is the highest allowable value for the average of daily discharges over a calendar week.*
      iv. *For pollutants with limitations expressed in units of mass, the daily discharge is the total mass discharged over the day. For limitations expressed in other units, the daily discharge is the average measurement of the pollutant over the period of a day.*
5. *Document the Calculation of WQBELs in the Fact Sheet.*

In this EPA approach to developing permit limits, WLAs are calculated using the same mass balance equations used to calculate the concentration of the pollutant at the edge of the mixing zone in the reasonable potential analysis. To calculate the wasteload allocations, the downstream concentration (Cd) is set equal to the acute or chronic water quality criterion and the equation is solved for the allowable effluent concentration (Ce). The calculated Ce is the acute or chronic WLA. The equation is rearranged to solve for the WLA, becoming:

$$Ce = WLA = (CdQd - Cu(Qu \times MZ)) / Qe$$

These procedures for calculating effluent limits are based on the EPA 1991 TSD for control of toxic pollutants. The EPA permit writers' guidance provides an approach to the development of effluent limits, however it may not be applicable to managing nutrient discharges because of the use of extreme values, critical conditions, and statistical extremes to establish the long-term averages. For nutrients, the critical conditions are significantly different and should be based on far-field nutrient driven eutrophication.

The objective of the effluent limitations is to protect overall receiving water, both near and far field, and over both short- and long-term durations. Limiting nutrients with MDLs provides no benefit to the receiving water or the operation of the treatment facility. Biological patterns responding to nutrients occur over a physical reach of the receiving water and over seasonal periods. Managing these biological patterns with nutrient limitations is accomplished most appropriately by mimicking the biological patterns of the receiving waters. Seasonal nutrient limitations for the duration of a growing season may better match the longer term growing season eutrophication in the far-field watershed.

Chapter 2.0 includes a more detailed discussion about the 40 CFR 122.45(d) requirements that effluent limits must be expressed as monthly and weekly limits for municipal permits "unless impracticable." Effluent limits may well warrant the use of longer term averages, as has been shown to be the case for Chesapeake Bay and the Spokane River where monthly and weekly effluent limits were determined to be impracticable.

3.3 Case Study Example

This section presents a case study example of the development of effluent nutrient limits as given to a stakeholder group during the numeric nutrient criteria rulemaking process in Montana (Montana DEQ, 2014a, b) by staff from the Montana Department of Environmental Quality (Montana DEQ, 2011a). The development of the nutrient limits follows the EPA TSD approach for toxics. The example was a fictitious situation intended to provide guidance to permit writers in Montana (Chambers, 2011a, b). The numeric nutrient criteria for total nitrogen (TN) of 300 ug/L and total phosphorus of 25 ug/L were taken from the Montana nutrient standards for wadeable streams (Montana DEQ, 2014a, b). The critical receiving water flow is based on a 14Q10 low flow, which was selected by Montana DEQ as the basis for application of the numeric nutrient criteria. Montana DEQ uses a 95% probability distribution of the effluent for calculation of the average monthly nutrient limits.

The example case study permit calculations include three different receiving water scenarios with effluent dilution ratios of zero, 50:1, and 3:1. In the zero dilution scenario, the effluent limits arrived at in the calculations results in an effluent average monthly total nitrogen limit of 300 ug/L using a CV of 0.2 and 299 ug/L using a CV of 0.6. Although not stated in the example from Montana DEQ, the effluent limits are technically infeasible and below limits of treatment technology for nitrogen removal.

In the scenario with 50:1 dilution with receiving waters, the calculated average monthly limits for total nitrogen are 9.469 mg/L and for total phosphorus 0.942 mg/L. This scenario resulted in technically attainable effluent limits primarily because the receiving water dilution rate is high at 50:1.

In the scenario with 3:1 dilution with receiving waters, the calculated average monthly limits for total nitrogen are 0.887 mg/L and for total phosphorus 0.0837 mg/L. While the effluent phosphorus limit is technically attainable, the effluent nitrogen limit that is less than 1 mg/L is not technically feasible and below limits of treatment technology for nitrogen removal.

"Nutrient Permitting Examples Based on DEQ-12
Reasonable Potential and Effluent Limits Based on Proposed Numeric Nutrient Standards

Following are examples of the permitting process for establishing Montana Pollutant Discharge Elimination system (MPDES) permit effluent limits based on the proposed numeric nutrient standards from version 5.4 of DEQ-12. The process follows the TSD in assessing the need for effluent limits (reasonable potential determination) and the development of those limits.

Because the standards are low, and many streams are already listed as impaired for nutrients, most facilities that discharge nutrients will have effluent limits in the MPDES permit.

The examples are for existing facilities and use Discharge Monitoring Report (DMR) data for the past five years. The receiving water N and P concentrations used are random values selected for example purposes only and are not based on any actual data.

Example 1: Major Wastewater Treatment Plant (WWTP) (zero dilution)

Maximum reported total N concentration = 14.04 mg/L; Total N numeric standard = 300 µg/L. Maximum reported total P concentration = 0.38 mg/L; Total P numeric standard = 25 µg/L. Receiving water 14Q10 = 0

Because the receiving water 14Q10 is zero, reasonable potential (RP) is assessed by simply comparing the maximum effluent values for N and P to their respective WQS. RP to exceed the standards exists.

Likewise, because the 14Q10 is zero, following the TSD, the water quality standard is used as the WLA for developing permit limits. From the WLA, the LTA effluent concentration necessary to achieve the WLA, based on the 95% probability distribution of the effluent, is calculated using a multiplier from TSD Table 5-1 as follows:

LTA = WLA x Table 5-1 multiplier

The Table 5-1 multiplier is dependent on the coefficient of variation in the facility effluent data and the 95th percentile. In cases where the Department does not have adequate data to calculate a CV, 0.6 is considered the default CV. The examples below show the difference between a calculated CV of 0.2 and the default CV.

LTA = 300 µg/L x 0.853 = 256 µg/L (CV = 0.2);

LTA = 300 µg/L x 0.644 = 193 µg/L (CV = 0.6)

From the LTA, an Average Monthly Limit (30-day average) is calculated based on a multiplier from Table 5-2 of the TSD.

AML = LTA x Table 5-2 multiplier

When establishing an average monthly limit, the multiplier is selected based on the both the CV of the data set and the number of samples to be collected during the monthly monitoring period. For a facility this size the Department typically requires at least 4 samples per monitoring period for nutrients.

AML = 256 ug/L x 1.17 = 300 ug/L (n = 4; CV = 0.2);

AML = 193 µg/L x 1.55 = 299 µg/L (n = 4; CV = 0.6)

If fewer than four samples were required during a monitoring period the effluent limits would be slightly higher: 320 µg/L (n=2, CV = 0.2) and 348 µg/L (n = 1).

DEQ-12 states that only 30-day average values will be used for nutrient limits, so the applicable AML above would be the effluent limit in the permit. The limits would be effective July – September only.

Example 2: Major Wastewater Treatment Facility (approximately 50:1 dilution)

In this example RP is assessed after considering available dilution using a simple mass balance:

RWC = (QdCd + QuCu) / Qr
RWC = Projected maximum receiving water concentration
Qd = Effluent Flow rate
Cd = Estimated maximum effluent concentration based on CV of the data (from TSD Table 3-2)
Qu = Receiving stream 14Q10
Cu = Instream background concentration (100 µg/L – N; 5 µg/L – P)
Qr = 14Q10 + Effluent flow rate

Using total nitrogen as an example: The maximum reported effluent concentration from this facility is 15.9 mg/L. The TSD requires us to establish a "projected" maximum concentration, based on the variability of the effluent (represented by the coefficient of variation, CV) and the number of samples in the data set. The maximum reported concentration is multiplied by a reasonable potential multiplier from Table 3-2 in the TSD (95th percentile). This value is Cd in the formula above.

For nitrogen:

RWC = ((1.984 mgd)(21,000 µg/L) + (91.1 mgd)(100 µg/L)) / 93.1 mgd = 545 µg/L

	Maximum Concentration (Reported / Projected Cd) (µg/L)	Effluent Flow Rate (mgd)	Receiving Water 14Q10 (mgd)	TSD Projected Maximum Receiving Water Concentration-RWC (µg/L)	Proposed Numeric Standard (µg/L)
Total Nitrogen	15,900 / 21,000	1.984	91.1	545	300
Total Phosphorus	9,600 / 12,500			270	25

The RWC exceeds the numeric standard; reasonable potential exists; and effluent limits are necessary.

Next a WLA is established using the mass balance approach and taking into account available dilution.

WLA = (QrCr – QuCu) / Qd

Qr = 14Q10 + Effluent flow rate

Cr = Water quality standard (proposed numeric standard)

Qu = 14Q10

Cu = Instream background concentration

Qd = Effluent flow rate

Continuing to use nitrogen as an example, the values in the table below are used in the above formula to calculate a WLA of 9,486 µg/L. The WLA is the concentration of nitrogen the facility can discharge and comply with the water quality standard.

For nitrogen:

WLA = ((91.1 mgd + 1.984 mgd)(300 µg/L) – (91.1 mgd)(100 µg/L)) / 1.984 mgd = 9,483 µg/L

	Proposed Numeric Standard (µg/L)	Effluent Flow Rate (mgd)	Receiving Water 14Q10 (mgd)	Instream Background Concentration (µg/L)	WLA (µg/L)
Total Nitrogen	300	1.984	91.1	100	9,483
Total Phosphorus	25			5	944

For developing effluent limits, the WLA is considered the chronic WLA. From this WLA, the long-term average (LTA) effluent concentration necessary to achieve the WLA, based on the 95% probability distribution of the effluent, is calculated using a multiplier from TSD Table 5-1 (chronic) as follows:

LTA = WLA x Table 5-1 multiplier

The Table 5-1 multiplier is dependent on the coefficient of variation in the facility effluent data and the 95th percentile. In cases where the Department does not have adequate data to calculate a CV, 0.6 is considered the default CV.

	WLA (µg/L)	Table 5-1 Multiplier (CV= 0.6)	LTA (µg/L)
Total Nitrogen	9,486	.644	6,109
Total Phosphorus	944		608

From the LTA effluent limits are calculated, taking into account the variability of the effluent and the number of samples required, by simply multiplying the LTA by the appropriate average monthly limit multiplier in TSD Table 5-2.

	LTA (µg/L)	Table 5-2 Multiplier (CV= 0.6; n =4)	AML (µg/L) CV=0.6; n=4
Total Nitrogen	6,109	1.55	**9,469**
Total Phosphorus	608		**942**

These limits AML would be effective July – September only.

Example 3: Major WWTP (approximately 3:1 dilution)

Assuming that RP is established, effluent limits are developed as in the previous examples (using the same assumptions for instream concentrations, CV, number of samples, etc.).

	Standard (µg/L)	WLA (µg/L	LTA (µg/L) CV = 0.6	AML (µg/L) CV = 0.6 n = 4
Total Nitrogen	300	888	572	**887**
Total Phosphorus	25	83.8	54.0	**83.7**

Effluent Limits Based on Variances

The draft version of DEQ-12 (version 5.3) expresses the variance values as long-term averages. Part 2.2 of DEQ-12 proposes expressing permit limits for nitrogen and phosphorus (based on the proposed numeric nutrient standards) as 30-day averages only. Limits based on the variances will also be expressed as 30-day averages.

Using the TSD, effluent limits developed from LTA values depend on the coefficient of variation (CV) of the data set (the actual nitrogen or phosphorus results from the facility in question) and the number of samples that will be collected during the monthly reporting period. Unless sufficient daily data is available, the Department uses a default CV of 0.6 to make reasonable potential determinations and to calculate effluent limits. Where the only data available to the Department is summary data reported on DMRs, the default CV of 0.6 is used. The Department will only use a calculated CV when all of the individual sample results are available. The number of samples collected during a reporting period depends on the facility type and is specified in the monitoring requirements of the MPDES permit.

Because the variances are expressed as LTA and the limits are expressed only as 30-day averages, the calculation of effluent limits, following the TSD, is straight forward. The variance numbers are simply multiplied by the appropriate LTA multiplier (depending on CV and number of samples) for the AML at the 95th percentile.

Total Nitrogen

CV	No. Samples	TSD Table 5-2 Multiplier	AML (ug/L) based on 10,000 ug/L LTA	AML (ug/L) based on 15,000 ug/L LTA
0.1	4	1.08	10,800	16,200
	2	1.12	11,200	16,800
	1	1.17	11,700	17,550
0.6	4	1.55	15,500	23,250
	2	1.80	18,000	27,000
	1	2.13	21,300	31,950

Total Phosphorus

CV	No. Samples	TSD Table 5-2 Multiplier	AML (ug/L) based on 10,000 ug/L LTA	AML (ug/L) based on 15,000 ug/L LTA
0.1	4	1.08	1,080	2,160
	2	1.12	1,120	2,240
	1	1.17	1,170	2,340
0.6	4	1.55	1,550	3,100
	2	1.80	1,800	3,600
	1	2.13	2,130	4,260

3.3.1 Analysis of Case Study Examples

The case study examples from Montana DEQ used a literal interpretation of numeric nutrient criteria and the EPA 1991 TSD to establish nutrient effluent limits with the assumption that nutrients behave like toxic compounds. In the case of zero dilution and 3:1 dilution, the effluent nitrogen effluent limits that are arrived at using the EPA TSD procedure are well below the limits of advanced nutrient removal treatment technology and are technically infeasible. Compliance with discharge permits developed using this approach would not be feasible. Therefore, a regulatory solution would be required, such as the nutrient variance developed in Montana for use in conjunction with the numeric nutrient criteria.

CHAPTER 4.0

TECHNOLOGY-BASED EFFLUENT LIMITS

TBELs are intended to prevent pollution by requiring a minimum level of effluent quality that is achieved using treatment technologies for reducing discharges of pollutants to surface waters. There are no federally mandated technology-based standards for nutrients, nor is nutrient removal required as part of secondary treatment standards, although there have been calls for nutrients to be included in secondary treatment standards. The CWA established a "secondary treatment" performance level that all POTWs are required to meet in sections 301(b)(1)(B) and 304(d)(1). The EPA developed and promulgated "secondary treatment" regulations that are found in 40 CFR 133.102. These technology-based limits identify the minimum level of effluent quality attainable by secondary treatment in terms of five-day biochemical oxygen demand (BOD5) or five-day carbonaceous biochemical oxygen demand (CBOD5), TSS, and pH. No comparable federal requirements exist for nitrogen and phosphorus, nevertheless technology-based effluent limits are applied for nutrients in many situations. In the absence of national standards, technology-based effluent limits are developed on a case-by-case basis.

This chapter presents a discussion of the application of technology-based effluent limits for nutrients, including circumstances where this approach to limiting nitrogen and phosphorus discharges is potentially appropriate. Examples of the application of technology-based limits for nutrients are provided to highlight the discussion.

4.1 Use of Technology-Based Effluent Limits

Technology-based effluent limits identify the performance of a wastewater treatment process by directly defining effluent phosphorus and nitrogen concentrations. In this approach, a treatment plant is required to achieve effluent quality that may be established by a variety of methods, such as selection of general treatment levels associated with a degree of technology. Examples include biological nutrient removal (BNR), or enhanced nutrient removal (ENR), or limit of technology (LOT). Conventional municipal biological nutrient removal typically produces effluent total nitrogen of about 8 to 10 mg/L and total phosphorus of about 0.5 to 1 mg/L. Enhanced nutrient removal is an upgrade of the conventional nutrient removal technology to include additional reliability and performance enhancements, larger biological reactors, supplemental chemical addition, effluent filtration, etc. These processes typically produce effluent total nitrogen of about 3 to 5 mg/L and total phosphorus of about 0.1 to 0.5 mg/L. At the limits of treatment technology with the largest reactors, state-of-the-art processes, supplemental chemical addition, sidestream controls, enhanced/optimized operations, continuous monitoring, etc. to achieve the lowest effluent concentrations, effluent total nitrogen of 3 mg/L or less, and total phosphorus of 0.1 mg/L or less, may be achieved.

These generalized characterizations of levels of treatment do not address how long a stated performance can be sustained, nor the reliability and resiliency of such performance. More specific and detailed information is needed to address those considerations (Chapter 5.0). Altered effluent nutrient speciation and bioavailability are also not addressed by these generalized characterizations.

4.2 Benefits and Limitations

A key benefit of the application of technology-based effluent limits for nutrients is the simplicity of the approach. Effluent phosphorus and nitrogen limits are specified at levels that can be inserted directly into discharge permits. The basis for the selection of technology-based effluent limits for nutrients may vary and could be nominal values associated with a given level of advanced nutrient removal treatment. Alternately, effluent limits have been based on interim levels of treatment with the expectation in the long term that water quality-based effluent limits will be derived, or result from a wasteload allocation in a TMDL, that eventually replaces the initial technology-based effluent limits. In other circumstances, a statistical analysis of past effluent performance may be used to establish technology-based effluent limits. Technology-based effluent limits may be useful in achieving a degree of point source nutrient reduction while progress is made in developing all of the information necessary for the preparation of appropriate water quality-based limits. In this way, technology-based effluent limits may be a placeholder used with the expectation that they will later be replaced.

A potential criticism of technology-based effluent limits for nutrients is that they may be selected at levels which are perceived as being too lenient to actually be protective of receiving water quality. The primary disadvantage of technology-based effluent limits for nutrients is the lack of a relationship to the receiving water quality objectives. Consequently, it may not be clear whether technology-based effluent limits are over-protective, or under-protective, of receiving water quality. Receiving water quality is controlled by a multiplicity of factors with complex interrelationships in the aquatic environment. Point source nutrient load reductions from wastewater treatment plants may, or may not, contribute to water quality improvements depending upon many factors. These factors include the magnitude of point sources compared to other loadings, the limiting nutrient controlling aquatic growth in receiving waters, decomposition of aquatic growth, and many receiving water characteristics related to the processing of nutrients (light penetration, scour, substrate stability, etc.). 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 by zero discharge would have limited effect on water quality.

4.2.1 Benefits

Benefits of technology-based effluent limits for nutrients are summarized as follows:

- Simplicity in effluent discharge permitting.
- Selected effluent limits at levels where compliance is assured.

4.2.1.1 Limitations

Limitations of technology-based effluent limits are summarized as follows:

- Lacks a direct linkage with receiving water quality requirements.
- Suggests uniformity in nutrients limits is appropriate for all receiving waters, which is contradicted by the site-specific circumstances that define the actual impact of nutrient loadings on individual waterbodies.

4.3 Simplified Example

In this simplified example of the application of technology-based effluent limits in discharge permitting, a typical secondary treatment facility is assumed to discharge 10 mgd (15.5cfs) to surface waters. Receiving water quality requirements indicate that nitrogen and phosphorus reductions may be necessary, however no definitive in-stream endpoints have been established in terms of numeric nutrient criteria or a TMDL wasteload allocation. Technology-based effluent limits have been selected for nitrogen and phosphorus at 10 mg/L and 1 mg/L, respectively. It is anticipated that future water quality-based effluent limits will eventually supersede these values once receiving water quality studies are completed. In the meantime, effluent limits in the discharge permit will be structured as show in Table 4-1 for this simplified example.

Table 4-1 illustrates the structure of the discharge permit effluent limits table for this example and it is assumed that average monthly effluent limits are adequate to meet receiving water requirements, at least initially. Monthly concentration and mass limits are shown in Table 4-1, however it should be noted that discharge permits might be prepared with both, or either, mass or concentration limits and be adequate. Weekly limits might also be considered since the NPDES regulations (40 CFR 122.45(d)) require that all permit limits be expressed as average monthly limits and average weekly limits for POTWs and as both average monthly limits and maximum daily limits for all others, unless "impracticable." However, for this example, it assumed that since the technology-based effluent limits were simply selected values for nitrogen and phosphorus, that insufficient detail is available to further define weekly limits.

Table 4-1. Example of Final Effluent Limitations Based on Technology-Based Effluent Limits.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Average Monthly Limit**	**Average Weekly Limit**	**Maximum Daily Limit**
Total Nitrogen as N	mg/L	10.0	–	–
	lb/day	834	–	–
Total Phosphorus as P	mg/L	1.0	–	–
	lb/day	83.4	–	–

4.4 Example Applications of Technology-Based Nutrient Limits

Technology-based effluent limits have been applied to nutrient discharge permitting in many situations. These include discharges to receiving water where TMDLs are being prepared but are not completed, where an initial nutrient reduction is needed in an adaptive management approach, where past effluent performance statistics are used as the basis for limits, and where states are in the process of adopting numeric nutrient standards. The following sections highlight some of these situations with illustrations of the resulting discharge permit structures.

4.4.1 Hillsborough County, Florida – South County Regional Advanced Treatment Plant

Hillsborough County, Florida, operates the 10 mgd South County Regional Advanced Wastewater Treatment Facility (AWWTF) in Tampa. The plant includes a five stage Bardenpho biological nutrient removal process. Effluent is either reused or discharged to Port Redwing Canal to Hillsborough Bay, which ultimately leads to Tampa Bay where a nitrogen TMDL is in place.

Technology-based effluent limits apply to the South County Regional AWWTF for nitrogen and phosphorus. In Florida, the Grizzle-Figg Act of 1987 (Florida Statutes Section 403.086) redefined advanced wastewater treatment and required the Department of Environmental Protection to issue discharge permits to plants complying with the following effluent limits on an annual average basis:

- Five-day Biochemical Oxygen Demand (CBOD5) 5 mg/l.
- Suspended Solids 5 mg/l.
- Total Nitrogen, expressed as N 3 mg/l.
- Total Phosphorus, expressed as P 1 mg/l.

It should be noted that these are surface water discharge limits and Florida utilities with beneficial reuse do not need to meet the low 3 mg/l TN and 1 mg/l TP limits for surface water discharge. The reuse nitrogen limit is 10 mg/L for nitrate. Many utilities in Florida have reuse or deep well injection and have avoided the low surface water discharge nutrient limits.

The 5-5-3-1 effluent limits (CBOD5, TSS,TN,TP) applied to southwest Florida bays from Tarpon Springs to Charlotte Harbor, including Tampa Bay, Hillsborough Bay, Boca Ciega Bay, St. Joseph Sound, Clearwater Bay, Sarasota Bay, Roberts Bay, Lemon Bay and Charlotte Harbor Bay. Specific limits for the South County AWWTF include annual average, monthly average, weekly average, and maximum concentrations for a single sample, as shown in the Table 4-2. The annual average effluent nitrogen and phosphorus limits are set at 3 mg/L and 1 mg/L respectively. The monthly average, weekly average and single sample maximum effluent limits are calculated with multiplication factors established in state rules (Florida Rule 62-600.740 (1)(b)2.) as follows:

"b. The arithmetic mean of the pollutant values for a minimum of four reclaimed water or effluent samples each collected (whether grab or composite technique is used) on a separate day during a period of 30 consecutive days (monthly) shall not exceed one and one-quarter times the design concentration for the reclaimed water or effluent.

c. The arithmetic mean of the pollutant values for a minimum of two reclaimed water or effluent samples each collected (whether grab or composite technique is used) on a separate day during a period of 7 consecutive days (weekly) shall not exceed one and one-half times the design concentration specified for the reclaimed water or effluent.

d. Maximum-permissible pollutant concentrations in any reclaimed water or effluent grab sample shall not exceed two times the design concentration specified for the reclaimed water or effluent."

Table 4-2. Hillsborough County South AWWTF Nutrient Permit Limits for Surface Water Discharge.

Parameter	Units	Max/Min	Effluent Limitations			
			Annual Average	Monthly Average	Weekly Average	Single Sample
Nitrogen, Total	MG/L	Maximum	3.0	3.75	4.5	6.0
Phosphorus, Total	MG/L	Maximum	1.0	1.25	1.5	2.0

EPA approved a Tampa Bay TMDL in 1998 which established allowable nitrogen loads and chlorophyll-a thresholds for each segment of the Bay. The nitrogen loading for the TMDL is shared among three facilities; South County AWWTF, Falkenburg AWWTF, and Valrico AWWTF. The total 12-month rolling total is not to exceed 45.80 tons/yr, and the five year average of the yearly totals is not to exceed 30.40 tons/yr for the combined total load. On November 16, 2010, Florida Department of Environmental Protection (DEP) issued a final order adopting water quality-based effluent limits for point source nitrogen discharges to the Tampa Bay watershed.

4.4.2 Minneapolis MCES Metro Plant Phosphorus Limits

The Metropolitan Council Environmental Services (MCES) operates seven wastewater treatment facilities in the Minneapolis/Saint Paul metropolitan area. MCES has completed improvements at each of these facilities over the past 15 years, including projects that have reduced the effluent phosphorus load. The Metropolitan Wastewater Treatment Plant (Metro Plant) consists of an activated sludge process operated for nitrification and biological phosphorus removal. Phosphorus removal was implemented at the Metro Plant between 1997 and 2003 to meet phosphorus limits imposed at the end of 2005. The Metro Plant has a technology-based phosphorus effluent limitation of 1 mg/L and an associated annual mass loading limit, as shown in Table 4-3. Actual effluent phosphorus concentration performance is significantly less than permit limit. The pending Lake Pepin TMDL downstream may result in revised wasteload allocations that modify the Metro plant discharge permit.

Table 4-3. Metropolitan Council Environmental Services (MCES) Metro Plant Effluent Phosphorus Limits.

Parameter	Limit	Units	Limit Type	Effective Period
Phosphorus, Total	1.0	mg/L	12 Month Moving Average	Jan - Dec
Phosphorus, Total	431,077	kg/yr	12 Month Moving Total	Jan – Dec

4.4.3 LOTT Alliance Budd Inlet Plant, Olympia, Washington

The Budd Inlet Treatment Plant in Olympia, Washington, is operated by the LOTT Alliance. Lacey, Olympia, Tumwater, and Thurston County (LOTT) is comprised of the contributing jurisdictions of the City of Lacey, City of Olympia, City of Tumwater, and Thurston County. The enhanced biological nutrient removal system uses the four-stage Bardenpho process operated to target nitrogen removal. The plant discharges into Budd Inlet at the south end of Puget Sound. Budd Inlet is listed as impaired for dissolved oxygen (DO), pH, some metals, some organics, and Polychlorinated biphenyls (PCBs). Budd Inlet has had low dissolved oxygen and appears to have no capacity to accept additional nutrients during the critical period, and a TMDL is underway. Effluent discharge limits are expected to be modified once the TMDL is completed and wasteload allocations are finalized.

The NPDES permit for the Budd Inlet plant includes technology-based effluent concentration limits and associated mass limits for total inorganic nitrogen (TIN) as shown in Table 4-4. Seasonal TIN limits are specified with the average monthly TIN limit for spring (April and May) and fall (October) of 3 mg/L (338 lbs/d) and the average monthly TIN limit for summer (June through September) of 3 mg/L (288 lbs/d). Seasonal mass loadings are based on varying effluent flow rates for each seasonal period. The 3 mg/L concentration limit is based on an analysis of historical effluent performance.

Table 4-4. LOTT Budd Inlet Plant Effluent Nitrogen NPDES Permit Limits for the [a,b].

Parameter	Effluent Limits: Outfalls #001 & 002	
	Average Monthly	Average Weekly
Spring/Fall Season Total Inorganic Nitrogen (TIN)[c] (April, May, & October)	3 mg/L, 338 lbs/day	–
Summer Season Total Inorganic Nitrogen (TIN) [c] (June - September)	3 mg/L, 288 lbs/day	–

[a]LOTT Alliance: City of Lacey, City of Olympia, City of Tumwater, and Thurston County, Washington
[b]The average monthly and weekly effluent limitations are based on the arithmetic mean of the samples taken
[c]Total Inorganic Nitrogen (TIN) is the sum of the inorganic forms of Nitrogen (Nitrate, Nitrite, and Ammonia) each reported as Nitrogen. The TIN limit shall be a seasonal limit and shall apply from April 1, through October 31, of each year, with higher Spring and Fall loading limits.

4.4.3.1 Performance-Based Effluent Limits

The Washington Department of Ecology's (Washington DOE, 2005) practice is to not permit any increases in loading to an impaired waterbody that may exacerbate the impairment. In these circumstances, Washington DOE uses past effluent discharge data to derive a "performance limit" which represents the existing loadings. Washington DOE's Permit Writers Manual (Washington DOE, 2015) provides guidance on performance limit calculations and a spreadsheet that calculates performance-based effluent limits. Performance-based effluent limits are calculated using the formulas in Appendix E Lognormal Distribution and Permit Limit Derivations from EPA's TSD (U.S. EPA, 1991). Monthly average limits are in most cases based on the 95th percentile of the distribution of averages of daily values (U.S. EPA, 1991). The 95th percentile (0.05 probability) for monthly average was used for development of technology-based effluent limits when EPA developed the industrial effluent guidelines and secondary treatment standards.

4.4.4 Kansas Technology-Based Effluent Limits

Kansas developed a unique Surface Water Nutrient Reduction Plan (Kansas DHE, 2004) that proposed an initial step to controlling nutrient releases in the Mississippi River Basin. The plan proposed controls for large sewage treatment plants, along with targeted activities for nonpoint sources of nutrients, with the goal of improving water quality to protect drinking water and recreation resources, while continuing to explore nutrient criteria-based options. Kansas found that a combination of point and nonpoint reductions could meet a goal of 30% reduction in the export of nitrogen and phosphorus. Implementing BNR at the largest Kansas wastewater facilities could potentially meet 33% of the goal for total nitrogen and 46% of the goal for total phosphorus. The remainder of the reductions for nitrogen and phosphorus would be borne by nonpoint sources. Based on expected removal efficiencies for BNR, it was found to be feasible for the large wastewater facilities in Kansas to meet effluent limitations of 8 mg/L for TN and 1.5 mg/L for TP on an annual average basis.

4.4.4.1 City of Edgerton, KS NPDES Permit

An example effluent discharge permit from Kansas is summarized in Table 4-5 with technology-based effluent limits for nitrogen and phosphorus for the City of Edgerton. This permit was issued in 2012 and expires December 31, 2016. The initial effluent total phosphorus is limit is 0.5 mg/L and total nitrogen is 8 mg/L. The Edgerton permit includes a compliance schedule which further defines effluent nitrogen and phosphorus targets for the initial year of operation and subsequent years with target effluent levels:

"D. SCHEDULE OF COMPLIANCE This wastewater treatment facility is nutrient removal. For the first permittee will operate the treatment removal with the goal of achieving the designed and will be built to provide for year following substantial completion, the facility to maximize the level of nutrient following target effluent levels:

l. Total Nitrogen less than or equal to 8.0 mg/1 as an annual average.

2. Total Phosphorus less than or equal to 0.5 mg/1 as an annual average.

Following the first year after substantial completion, the total nitrogen and total phosphorous limits as provided in Table A above shall be enforceable and the target effluent levels shall become as follows:

1. Total Nitrogen less than or equal to 5.0 mg/1 as an annual average.

2. Total Phosphorus less than or equal to 0.3 mg/1 as an annual average.

These target effluent levels are not limits"

Table 4-5. City of Edgerton Effluent Limits for Nitrogen and Phosphorus.
Kansas DHE, 2012.

Effective Date	Effluent Limits Final Limits Upon Issuance	Monitoring Requirements
Parameter		**Measurement Frequency**
Total Nitrogen, mg/L[1]	8.0	Once Weekly
Total Nitrogen, lbs/day[1]	66.7	Once Weekly
Total Phosphorus, mg/L[1]	0.5	Once Weekly
Total Phosphorus, lbs/day[1]	4.2	Once Weekly

[1]Rolling annual average calculated monthly

4.4.5 Lake Spokane

Historically, a Long Lake management plan for phosphorus, now referred to as Lake Spokane, had an annual summer season load allocation. The Spokane River Phosphorus Management Plan specified NPDES permits requiring 85% removal of phosphorus or 1 mg/L on a monthly average basis, whichever was greater. A recent analysis suggests that this level of phosphorus control was successful in achieving water quality objectives (Welch, 2015). Further, these phosphorus controls achieved water quality objectives prior to a more recently completed dissolved oxygen TMDL discussed in Chapter 6 that includes much lower effluent limits for phosphorus.

> *"Lake Spokane became hypereutrophic due to nutrient input from a municipal wastewater facility. Following a 1977 reduction in wastewater total phosphorus (TP) from about 5 to 0.5 mg/L, lakewater quality and trophic state recovered rather quickly, going from hypereutrophy to meso-eutrophy in the first 7 years. After TP reduction, mean summer (Jun–Oct) inflow TP declined from 86 to 25 µg/L during that 7-year period. Mean summer epilimnetic chlorophyll (Chl) declined from 21 to 11 µg/L, and the mean volume-weighted (v-w) hypolimnetic seasonal minimum dissolved oxygen (DO) increased from 1.4 to 4.5 mg/L over that same period. Recent data (2010–2014) demonstrate continued recovery to meso-oligotrophy with the 5-year average minimum hypolimnetic v-w DO at 6.5 mg/L and mean inflow TP and epilimnetic Chl at 15 and 4 µg/L, respectively. The areal hypolimnetic oxygen deficit (AHOD) rate now averages 0.67 ± 0.12 g/m2 per day, which is 84% less than the pre TP-reduction AHOD (median 4.2 g/m2 per day). This recovery in DO indicators may be the clearest case of recovery from severe eutrophication for a reservoir, which usually have higher AHODs than lakes. The recovery confirms the close link among TP inflow concentration, Chl, and DO in reservoirs, despite their relatively large watersheds and inflows that produce high nutrient loadings compared to natural lakes. The results show that reduction of phosphorus recovered the lake to meso-oligotrophy, even though nitrogen was initially limiting as much or more than phosphorus during hypereutrophy, and despite markedly increased inflow nitrogen since 2000." (Welch, 2015)*

The conclusions of this investigation (Welch, 2015) include the following:

- *These results clearly show that wastewater P reduction has alone recovered Lake Spokane from hypereutrophy to meso-oligotrophy as inflow TP continues to decline, despite markedly increasing inflow N concentrations.*
- *Moreover, DO has dramatically increased to the degree that much more improvement is unlikely even if inflow TP were to decrease further from its current low of 14 µg/L.*
- *These results indicate that N reduction in addition to P reduction would not have been cost-effective to manage Lake Spokane water quality.*

4.5 State Numeric Nutrient Criteria Rulemaking

In the course of numeric nutrient criteria rulemaking, several states have used technology-based effluent limits as a basis for the initial levels of point source nutrient controls. The development of numeric nutrient standards in Wisconsin, Colorado, and Montana has been accompanied by the consideration of implementation guidance for nutrient discharge permitting. In these states, diverse groups of stakeholders have participated in collaborative nutrient workgroups to craft both nutrient standards and implementation guidelines. An important driver in the dialog in these states has been the recognition of the potential for water quality standard rulemaking to result in infeasible WQBELs. That understanding of the gap between what may be required of new numeric nutrient standards, and the capabilities of wastewater facilities to comply with those standards, has led to unique regulatory solutions.

While each of these states has undertaken a unique process shaped by state-specific considerations of water quality, there are some commonalities. In each state, questions have been raised about the adequacy of water quality data and the cause and effect relationship between nutrients and beneficial uses. The cost of wastewater treatment to meet new nutrient standards has been a topic of discussion, as have watershed loadings and nonpoint sources, adaptive management approaches, and compliance schedules for meeting new standards. Technology-based effluent limits have been adopted in each of these states as an initial point source nutrient control approach. Table 4-6 summarizes the technology-based effluent limits in use in in Wisconsin, Colorado, and Montana.

Table 4-6. Summary of Technology-Based Effluent Nutrient Limits in Wisconsin, Colorado, and Montana.

State/Basis	Technology-Based Effluent Limit		Compliance Basis
	Phosphorus	Nitrogen	
Colorado			
Existing Plant, Flow > 1 mgd	1 mg/L TP	15 mg/L TIN	Running Annual Median
	2.5 mg/L TP	20 mg/L TIN	95th Percentile of past 12 months
New Plants, Flow > 1 mgd	0.7 mg/L TP	7 mg/L TIN	Running Annual Median
	1.75 mg/L TP	14 mg/L TIN	95th Percentile of past 12 months
Montana			General Variance Limits
Plant Flow > 1 mgd	1 mg/L TP	10 mg/L TIN	Monthly Average
Plant Flow < 1 mgd	2 mg/L TP	15 mg/L TIN	Monthly Average
Lagoons not designed to actively remove nutrients	Maintain current performance	Maintain current performance	
Wisconsin			
Effluent Standard	1 mg/L	–	12-Month Running Average
	Watershed Adaptive Management Option		
First permit Reissuance	< 0.6 mg/L	–	6-month average
2nd permit Reissuance	< 0.5 mg/L	–	6-month average
Subsequent Reissuance	Water Quality Based Effluent Limits	–	

4.5.1 Wisconsin Nutrient Standards

In 2010, Wisconsin passed parallel legislation for water quality criteria for phosphorus and implementation guidance on discharge permitting. Chapter Natural Resources (NR) 217 Effluent Standards and Limitations for Phosphorus defines an adaptive management approach to implementation. Numerical effluent limits for wastewater treatment plant discharges are based on incremental reductions from an initial permit at 1 mg/L for total phosphorus and in subsequent permit cycles at <0.6 mg/L, <0.50 mg/L and ultimately to water quality-based effluent limits. Discharge permit compliance will be based on a running 12-month average basis.

4.5.2 Colorado Nutrient Standards

In 2012, Colorado passed two state regulations to establish in-stream nutrient target values and technology-based effluent limits. A revision to Colorado Regulation 31 for surface water nutrient standards for cold and warm waters established in-stream target values for chlorophyll-a, phosphorus, and nitrogen. A new Nutrients Management Control Regulation (Colorado Regulation No. 85) establishes technology-based numeric nutrient limits for point source discharges. Effluent limits for existing treatment plants will be 1 mg/L total phosphorus (TP) and 15 mg/L TIN based on what has been labeled “first level” three-stage BNR. New treatment plants will be expected to be four- and five-stage BNR for effluent of 0.7 mg/L TP and 7 mg/L TIN. Discharge permit compliance will be based on a running annual median basis.

4.5.3 Montana Nutrient Standards

Following a number of years of water quality studies and nutrient work group meetings, nutrient criteria discussions have matured to rulemaking in 2014 in Montana. This follows the passage of two legislative bills providing for water quality variances from numeric nutrient criteria. In 2009, Montana Senate Bill 95 passed and provided for temporary nutrient standards under two conditions: 1) affordability and 2) limits of treatment technology. In 2011, Montana Senate Bill 367 was passed to provide for nutrient standards variances on a statewide general basis, and also for individual and alternative variances. Larger treatment facilities are required to meet effluent limits of 1 mg/L TP and 10 mg/L TN (flows greater than 1 mgd) based on a monthly average basis. Smaller facilities are required to meet 2 mg/L TP and 15 mg/L TN (flows less than 1 mgd).

4.5.4 Iowa Nutrient Reduction Strategy

Iowa developed a nutrient reduction strategy in response to the 2008 Gulf Hypoxia Action Plan that uses technology-based effluent nutrient limits. The Iowa Department of Natural Resources is working with point source dischargers to pursue a goal of 16% phosphorus reduction and 4 percent nitrogen reduction (Iowa DNR, 2012). When discharge permits are renewed, dischargers are required to conduct a 2-year study to evaluate the costs of installing biological nutrient removal and submit a schedule for making improvements. Technology-based effluent limits will be incorporated into discharge permits with limits no more stringent than 10 mg/L total nitrogen and 1 mg/L total phosphorus. After biological nutrient removal facilities are operational, dischargers have a one year optimization period prior to limits being set based on demonstrated treatment performance, but no more stringent than 10 mg/L nitrogen and 1 mg/L phosphorus. Treatment plants will be protected from stricter effluent limits for 10 years if nutrient removal is installed. Facilities will have monthly limits for nitrogen and phosphorus and compliance will be determined based on the annual average, rather than by the monthly limits.

4.6 Petition for Rulemaking to Include Nutrients in the Definition of Secondary Treatment

On November 27, 2007, the Natural Resources Defense Council (NRDC) filed a Petition for Rulemaking with the EPA to limit nutrient pollution from wastewater treatment facilities (NRDC, 2007). Joining NRDC in the petition were 10 other regional and national environmental groups, including the Sierra Club and American Rivers. NRDC contended that EPA must protect the public and the nation’s water quality by establishing nitrogen and phosphorus limits as part of the base technology definition of secondary treatment.

NRDC argued that nutrient pollution is widespread and justifies a generally applicable standards approach to treatment for nutrients. The NRDC contended that nutrient control is properly included within “secondary treatment” and cited the following as facts:

- Effluent TP 0.3 mg/l and TN 3 mg/l is Consistently Attainable Using Current Technology.
- Effluent TP 1 mg/l and TN 8.0 mg/l is Attainable with Existing Technology Using Only Improved Biological Treatment Processes.

NRDC argued that EPA’s reliance on site-specific standards is unreasonable in light of pervasive nutrient pollution and the lack of numeric nutrient standards, which hinders the ability to require water quality-based effluent limitations. NRDC called for EPA to specify the degree of nitrogen and phosphorus reduction attainable through secondary treatment with technology-based effluent limits.

4.6.1 Basis for EPA’s Rejection of Technology-Based Effluent Limits

On December 14, 2012, EPA rejected the NRDC petition for rulemaking on secondary treatment standards (U.S. EPA, 2012a). EPA’s action in rejecting the petition is significant in that the approach advocated by NRDC would have had far reaching effects on many wastewater utilities by applying a uniform standard for nutrient removal with technology-based effluent limits despite widely varying water quality conditions across the country. Instead, EPA emphasized that states should adopt numeric nutrient criteria and interpret existing narrative standards to control nutrients.

The EPA Deputy Assistant Administrator explained EPA’s reasoning in rejecting the NRDC petition (U.S. EPA, 2012a). In answering the petition, EPA noted that secondary treatment technology is not designed for nutrient removal and found that there was insufficient data to draw any general conclusions about the ability of secondary treatment to removal nutrients. EPA determined that setting uniform technology-based effluent limits for nutrients is not warranted at this time and that EPA is effectively pursuing control of wastewater discharges of nutrients with site-specific, water quality-based effluent limits. EPA noted that setting uniform national limits for nutrients would have a high cost for POTWs, even when incurring those costs was not necessary to protect water quality.

Although EPA stated that eliminating nutrient pollution is one of EPA’s top priorities, EPA determined that revising secondary treatment standards to include technology-based effluent limitations for nutrients is not warranted at this time. In making this determination, EPA noted that the need to control nutrients is highly site-specific and not suited to a national rule with minimum technology-based nutrient limits. EPA’s preferred approach is to continue to use water quality-based permitting and allow states the flexibility to determine where point source nutrient controls are warranted.

Secondary treatment technology standards were originally to be met by 1977 and Best Practicable Waste Treatment Technology (BPWTT) which was envisioned to include nutrients, by 1983. However, Congress repealed the 1983 deadline for BPWTT in recognition of the lack of federal funding in the Municipal Wastewater Treatment Construction Grants Amendments of 1981. EPA's decision to deny the NRDC petition included consideration of the intent of Congress in balancing policy with use of public funds. Substantial costs would be incurred by wastewater utilities to comply with a national secondary treatment standard that included new nutrient limitations.

EPA refuted the NRDC assertion that minor retrofits to existing treatment facilities would allow cost effective reduction of nutrient discharges. EPA found that NRDC underestimated the actual cost of retrofits and overlooked many smaller facilities throughout the country that employ trickling filters, lagoons, and oxidation ponds that would not be easily retrofit for nutrient removal. EPA found that the examples cited by NRDC were already using some form of advanced treatment which would be much easier to retrofit, especially if under-loaded with available capacity, which was a site-specific condition and consideration.

CHAPTER 5.0

TECHNOLOGY PERFORMANCE STATISTICS AND PERMITTING

The understanding of advanced wastewater treatment for nutrient removal has improved substantially in recent years through operational experience, technology development and research studies, and new efforts to meet more challenging discharge permits with increasingly challenging effluent nitrogen and phosphorus limits at lower levels. Application of the additional unit processes and biological treatment modifications needed to accomplish the required levels of nutrient removal has resulted in more effluent performance data from full-scale facilities, which has been studied in detail. This has provided an opportunity to define treatment performance in statistical terms based on the best designed and operated nutrient removal treatment facilities. This presents an opportunity to incorporate an improved understanding of advanced nutrient removal treatment performance in discharge permitting statistically. TPS describe the requirements for treatment facilities in more specific terms than common adjectives such as Advanced Treatment, Enhanced Biological Nutrient Removal, and Tertiary Treatment. Technology performance statistics can define effluent performance on average, as well as characterize the reliability expectations for the process, and the best possible effluent performance. This statistical information can be used to compare with the conditions necessary to satisfy receiving water requirements and to define the requirements of the treatment process for facility designers.

Effluent characteristics used to develop permit conditions should be from properly designed and operated facilities. The statistical analysis presented in this chapter provides an outline of how such an assessment can be conducted.

This chapter summarizes technology performance statistics, including a discussion of potential applications in effluent discharge permitting. Linkages between technology performance statistics and receiving water quality modeling and probabilistic assessments of receiving conditions for discharge permitting are discussed in Chapters 6.0 and 7.0.

5.1 Use of Technology Performance Statistics in Permitting

TPS describes the performance of a technology or process or facility under specific conditions. Neethling et al. (2009) introduced this method for using a statistical approach to describe process performance. In this approach, the treatment plant or technology performance is tied to the statistical rank to express the probability of achieving a certain performance. Building on this statistical approach, the term TPS was used at a Water Environment Federation Technical Exhibition and Conference (WEFTEC) workshop (WEF/WERF, 2009) to assess the performance of full scale treatment plants. The TPS is determined from performance data and is linked to the operational conditions during which the data were collected (pilot, full scale, summer, winter, excess capacity available, SRT, etc.). The conditions must also include external factors that impact the technology, industrial loadings, seasonality, absence of recycle streams, etc.

5.1.1 Benefits and Limitations

A key benefit of the application of technology performance statistics to effluent discharge permitting is to define limits in terms that account directly for variability in effluent performance when pursuing lower nitrogen and phosphorus levels. This presents the opportunity to take advantage of all of the recently available information about the capabilities of nutrient removal in very specific numerical terms. Effluent limits may be based directly on technology performance statistics, such as the average or median performance for a treatment process. Probability statistics for effluent performance, such as the 95^{th} percentile, can be linked to commonly used discharge permit structures, such as monthly limits. The advantage of using performance statistics is to define effluent limits in terms that account for realistic expectations for variability in effluent performance, as opposed to potentially overly restrictive absolute terms that presume that effluent limits will never be exceeded. In this way, discharge permit compliance issues can be avoided and unrealistic or technically infeasible permit requirements avoided.

The primary limitation of technology performance statistics is the focus on the capabilities of the nutrient removal treatment process itself, and not the linkage with receiving water quality requirements. While technology performance statistics provide an enhanced numerical description of treatment process performance, they do not define the frequency or duration of receiving water quality requirements. To do that requires receiving water quality monitoring and modeling to provide the information necessary to assess the allowable level of effluent variability.

5.1.1.1 Benefits

Benefits of technology performance statistics are summarized as follows:

- Accurate numerical depiction of the capabilities of nutrient removal treatment.
- Allows direct accounting for effluent variability.
- Provides a statistical definition of effluent performance requirements.
- Defines process design requirements in terms of average and reliable treatment performance.

5.1.1.2 Limitations

Limitations of technology performance statistics are summarized as follows:

- Requires detailed performance data for the treatment process.
- Lacks a direct linkage with receiving water quality requirements.

5.1.2 Simplified Example

In this simplified example of the application of technology performance statistics in discharge permitting, a typical secondary treatment facility is assumed to discharge 10 mgd (15.5cfs) to surface waters. Receiving water quality requirements dictate that reductions in phosphorus be made and that on average, effluent total phosphorus must be 0.100 mg/L. Technology performance statistics for a number of phosphorus removal processes are presented later in this chapter. For this example, TPS based on effluent total phosphorus from a biological phosphorus removal facility with effluent filtration could be used to define average limits in terms of the median (50^{th} percentile) and if necessary, weekly limits as well (80^{th} percentile).

Table 5-1 illustrates the structure of the discharge permit effluent limits table for the simplified example. In this example, it is assumed that average effluent phosphorus concentration is adequate to meet receiving water requirements and that variability above or below the median is acceptable. The weekly limits show in Table 5-1 could be based on appropriate treatment performance statistics which may, or may not, be necessary depending upon receiving water conditions. Monthly and weekly concentration and mass limits are shown in Table 5-1, however it should be noted that discharge permits might be prepared with both, or either, mass or concentration limits and be adequate.

Table 5-1. Example of Final Effluent Limitations Based on Technology Performance Statistics.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Median Monthly Limit**	**Median Weekly Limit**	**Maximum Daily Limit**
Total Phosphorus as P	mg/L	0.100	0.180	–
	lb/day	8.3	15.0	–

5.2 Relating Treatment Technology Information to Discharge Permitting

Capabilities of wastewater treatment technology and the requirements of receiving waters converge at the intersection of effluent limits in NPDES permits. This intersection in permitting requires information about both effluent and receiving waters that is similar, yet distinct. Any evaluation, regardless of the method of analysis selected, needs data that characterizes both effluent and receiving waters. While the parameters are the same, nearly everything else is slightly different, from the technical professionals who work in fields of wastewater treatment and natural waters, to the techniques used to measure and report flow and nutrient concentrations. These differences can present challenges and the potential for misinterpretation when analyzing the datasets. Permit writers working at regulatory agencies generally tend to be more comfortable working with natural waters than wastewater effluent. While excellent information about wastewater is available, information about how to translate and interpret that information to align with information about receiving waterbodies and then combine them to evaluate water quality is less readily available.

An additional challenge related to wastewater effluent data is the overwhelming reliance on past performance data. Examining effluent data for permitting requires prediction of future conditions and the potential impacts to receiving water quality. Past performance may not accurately characterize future conditions, especially after fundamental changes are made in effluent quality following nutrient removal treatment. This is where treatment technology performance statistics should be considered. Since receiving water quality and effluent quality varies, they both have stochastic characteristics. However this variability may be randomly determined. While this variability may not be predicted precisely, a random probability distribution or pattern may be analyzed statistically to represent conditions.

The foundation for arriving at feasible effluent nutrient limits in permitting lies in a shared understanding of the capabilities of advanced nutrient removal treatment and the response of receiving waterbodies receiving to nutrient discharges. Technology performance statistics provide a precise way of describing the capabilities of nutrient removal treatment to produce low effluent nitrogen and phosphorus concentration effluent.

5.2.1 Nutrient Removal Treatment Technologies

For general overview considerations, treatment technologies and process trains can be linked to expected nutrient quality in terms of effluent nitrogen and phosphorus concentrations. The effluent performance level depends on a variety of factors, including the process design, the influent composition of the wastewater, and in particular the availability of readily biodegradable organics. General classifications for advanced treatment are often used to represent the effluent nutrient concentrations expected from broad categories of advanced treatment levels (Clark, 2010).

Conventional municipal nutrient removal is typically a modification of a secondary treatment process or series of processes. The resulting effluent total nitrogen is usually about 8 mg/L and total phosphorus is about 1 mg/L. These effluent levels are achievable with conventional nutrient removal technologies. Chemical addition or filtration is typically not required.

Enhanced nutrient removal is an upgrade of the conventional nutrient removal technology to include additional reliability and performance enhancements. These processes often include multiple upgrades with chemical addition to supplement removal. Effluent total nitrogen is usually about 3 mg/L and total phosphorus is about 0.1 mg/L. Enhanced removal requires tertiary treatment and chemical addition to achieve low concentrations.

Best achievable performance with the maximum potential capabilities are characterized as tertiary and beyond treatment processes. These usually include multiple upgrades and processes to achieve the lowest effluent concentrations. Pursuit of effluent total nitrogen of about 1 mg/L and total phosphorus of 0.01 mg/L requires state-of-the-art technology, enhanced/ optimized treatment and operation, which may or may not be feasible, especially the simultaneously attainment of both very low nitrogen and phosphorus levels.

These are very general characterizations of levels of treatment and the associated treatment processes. It is important to recognize that while these processes may achieve nutrient concentrations at these levels, these general classifications of treatment levels do not address how long a stated performance can be sustained, nor the reliability and resiliency of such performance. More specific and detailed information is needed to address those considerations. Further, the resulting effluent nutrient speciation can be altered significantly depending on the treatment processes used. For example, biological nutrient removal can remove most fractions of phosphorus with relatively higher efficiencies towards bioavailable forms of phosphorus including soluble reactive phosphorus, particulate acid hydrolysable phosphorus, particulate reactive phosphorus portion, and organic phosphorus (Liu, 2011).

5.2.1.1 Nutrient Speciation Changes in Wastewater Treatment

Advanced levels of nutrient removal treatment impact effluent quality in multiple ways. First, effluent nitrogen and phosphorus concentrations are reduced. Second, nitrogen and phosphorus speciation is altered as a result of the advanced treatment processes. Third, the bioavailability of the remaining effluent nitrogen and phosphorus is reduced. After advanced nutrient removal treatment, the remaining nitrogen and phosphorus in treatment plant discharges may not be removable with current treatment technology

Nitrogen and phosphorus speciation is an important area of nutrient research, both in terms of biodegradability in wastewater treatment and bioavailability in the water environment.

WE&RF research into advanced levels of nutrient removal treatment is revealing new information about nitrogen and phosphorus speciation and reduced bioavailability of the nitrogen and phosphorus remaining after advanced treatment. This information has been published and is available to inform permitting considerations, especially at the lowest effluent nutrient levels at the limits of the capabilities of wastewater treatment technology. Slowly biodegradable or recalcitrant species may restrict the ability of treatment technologies to reduce nitrogen and phosphorus to lower effluent concentrations.

5.2.1.2 Operational Performance of Nutrient Removal Treatment

The effluent concentrations typical of the various levels of treatment technologies vary depending on multiple factors. Study results indicate that many factors, such as influent characteristics, type of process, solids management, and many others, affect treatment performance and reliability (Neethling and Stensel, 2013). Additionally each facility will have variability with its operational performance. Evaluating operational performance is important for interpreting past treatment plant performance in order to predict future results (Clark, 2010).

Performance is the statistically reliable concentration the treatment facility can achieve over some time period (Neethling and Pramanik, 2013). It is a numerical concentration over an averaging period such as daily, weekly, monthly, or annual. A reliable percentile may range from the 85th to the 99.9th percentage depending on the averaging period and the acceptable risk of not meeting a concentration (Bott and Parker, 2011).

A review of EPA methods for setting permit limits concluded that effluent variability should be considered implicitly or explicitly when setting water quality-based effluent limits (Bell et al, 2014). This recommendation includes addressing nutrient effluent variability and the appropriate timeframes associated with nutrient effects in the environment. Operational performance-based on statistical analysis and identification of reliable concentration percentiles is one component of improving the computation and determination of effluent limits.

5.3 EPA Guidance on Water Quality-Based Effluent Limits

EPA developed guidance for permit writers on water quality-based effluent limits (U.S. EPA, 2010) that references the approach recommended in EPA's Technical Support Document for Water Quality-based Toxics Control (U.S. EPA, 1991). The EPA TSD recognizes that effluent characteristics will be altered following advanced treatment and that investigations should be conducted to evaluate how this will influences effluent variability. In most cases, advanced wastewater treatment for nutrient removal will alter the statistical characteristics of effluent nitrogen and phosphorus concentrations and the variability will differ from historical effluent performance prior to the implementation of nutrient removal treatment. EPA's TSD addresses circumstances where both effluent concentration statistics will remain the same as historical effluent performance and when effluent variability is expected to change.

"The second approach for determining the allowable effluent concentration distribution is based on the assumption that effluent concentrations after treatment will not have the same CV as concentrations before treatment. Studies have documented that advanced secondary treatment increases the CV of BOD and total suspended solids concentrations compared to secondary treatment. <u>Where feasible, investigations should be conducted to evaluate how treatment processes for heavy metals, organic chemicals, and effluent toxicity will change the variability of these constituents.</u> The development documents mentioned above also provide some variability

data for treatment processes. To account for a change in variability, an alternative approach should be used to determine the allowable effluent distribution. Iterative model runs can be performed using different concentration means with the effluent "future treatment" variance until a mean is found that meets the criteria at the desired recurrence intervals. These iterative model runs require stochastic generation of effluent input data since daily effluent concentrations will not be available for the hypothetical treatment schemes. The required "future treatment" mean and CV of effluent concentration can then be used to set permit limits." (U.S. EPA, 1991).

As EPA suggested in the 1991 TSD, investigations have now been conducted to evaluate how advanced treatment processes change the variability of effluent nutrients to characterize the "future treatment" mean and CV of effluent concentration. The understanding of advanced wastewater treatment for nutrient removal has improved substantially in recent years and treatment technologies have been studied in detail. This has provided an opportunity to define treatment performance in statistical terms with TPS. Technology performance statistics define effluent on average, as well as characterize the variability in effluent concentration. This presents an opportunity to incorporate an improved understanding of advanced nutrient removal treatment performance in discharge permitting statistically.

5.4 Quantifying Treatment Technology Performance

Quantifying the capabilities of nutrient removal treatment processes has been the subject of many studies and a great deal of information is available upon which to base expectations for future performance of advanced treatment processes. These studies have contributed to expanding the understanding of the factors that influence effluent performance and reliability (Neethling et al., 2009; Neethling and Stensel, 2013; Bott and Parker, 2011; Clark et al., 2010; Ragsdale, 2007; Kang et al., 2008).

TPS provides an approach to quantify effluent nitrogen and phosphorus performance and reliability. Effluent quality and reliability of performance are defined statistically to describe the probability of achieving a specific concentration. For example, the median performance (representing the average treatment) is represented as the TPS-50% indicating that 50% of the data is below this value and 50% is above this level. A TPS-95% indicates a performance that is achieved 95% of the time; i.e., exceeded 5% of the time (Neethling et al., 2009).

Bott and Parker (2011) presented three technology performance statistics to describe the following:

- The Ideal TPS represented the best performance achievable and was characterized as the best two-week performance, represented by the 14-day statistic (or TPS-3.84%).
- The Median TPS represents the average performance and is calculated as the 50th percentile (TPS-50%).
- The Reliable TPS represents "a selected value depending on the technology, the averaging period used in the permit and the frequency of violations during the permit period selected by the plant owner based on the utility's risk tolerance." The Reliable TPS could be the 90th, 95th or 99th percentile of effluent performance (TPS-90% or TPS-95% or TPS-99%) or some other value reflecting the treatment process and receiving water objectives.

Some key technology performance statistics are summarized in Table 5-2 with notations on their calculation and interpretation.

Table 5-2. Application of Key Technology Performance Statistic Values.

Limit	Technology Performance Statistics (TPS)	Statistical Probability	Interpretation	Effluent Performance Implication
Best Achievable Performance	TPS-14d	3.84th percentile[1]	The best performance possible with the technology under the optimal or best operating conditions. This represents the LOT (Limit of Technology).	This limit will be exceeded 96% of the time.
Average Technology Achievable Limit	TPS-50%	50th percentile	This represents a measure of the concentration that was achieved on a statistical annual average basis.	As the median performance, the process exceeds this 6 times per year.[2]
Reliable Technology Achievable Limit	TPS-95%	95th percentile	This represents the concentration that can be achieved reliably by the technology.	This limit is exceeded 0.6 times[2] per year – 3 times in a 5 year period.

[1] Represents the lowest 14-d running average
[2] Times are months as typically reported in NPDES discharge permits

5.4.1 Treatment Process Performance Data

Data from a broad range of nutrient removal facilities have been used to assess treatment process performance. This information can serve as the basis for quantifying effluent performance expectations for future nutrient removal facilities subject to new effluent nutrient discharge permit limitations. Treatment process descriptions and effluent data from a variety of reference sources were summarized with technology performance statistics for 18 nitrogen removal facilities and 47 phosphorus removal facilities with tabulations of TPS-14d, TPS-50%, and TPS-95% statistics (Clark et al., 2010). Table 5-3 presents an example of the technology performance statistics for two select phosphorus removal facilities operating at low effluent concentrations. Technology performance statistics for two select nitrogen removal facilities are presented in Table 5-4. In addition to the technology performance statistics, Tables 5-3 and 5-4 present variability of effluent as characterized by ratios of the best achievable performance (TPS-14d) to average, and the 95th percentile performance to average. This information is important in permitting because it illustrates the high degree of effluent variability inherent in operating nutrient removal facilities at the lowest effluent concentration levels. For phosphorus, the range of the highest effluent concentrations to average may be on the order of more than three-to-one.

Table 5-3. Select Facilities Phosphorus Technology Performance Statistics (TPS) (Clark et al., 2010) and Effluent Variability.

	Technology Performance Statistic, TP (ug/L)			Effluent Variability as a Ratio Upon Average	
Facility	TP - TPS-14d	TP - TPS-50%	TP - TPS-95%	3.84th%/50th%	95th%/50th%
Clean Water Services (CWS) Rock Creek	25	65	210	0.38	3.23
Clean Water Services (CWS) Durham		70	100		1.43

Table 5-4. Select Facilities Nitrogen Technology Performance Statistics (TPS) (Clark et al., 2010) and Effluent Variability.

	Technology Performance Statistic, TN (mg/L)			Effluent Variability as a Ratio Upon Average	
Facility	TP - TPS-14d	TP - TPS-50%	TP - TPS-95%	3.84th%/50th%	95th%/50th%
Washington Suburban Sanitary Commission (WSSC)	2.1	3.4	6.2	0.62	1.82
City of Atlanta Utoy Creek WRC	6.14	9.94	13.37	0.62	1.35

5.4.2 Detailed Nutrient Removal Performance Analysis

Water Environmental Foundation (WEF) and WE&RF prepared a comprehensive study of nutrient removal plants designed and operated to meet very low effluent nitrogen and phosphorus concentrations (Bott and Parker, 2011). Operating data was gathered from 22 advanced nutrient removal facilities that provided three years of operating data that was analyzed using a consistent statistical approach that considered both process reliability and the permit limits applied. For plants analyzed for nitrogen performance, TN, ammonia nitrogen (NH3-N), nitrate plus nitrite nitrogen (NOx-N), and organic nitrogen (ON) were considered, where data was available. For phosphorus removal plants, the analysis considered both TP and ortho-phosphate-P (OP) where data was available.

Summary statistics were calculated in the WEF/WE&RF report including the arithmetic average (mean), geometric mean, standard deviation, CV, skew, minimum, and maximum. A time series plot was prepared from the data and a range of percentile statistics were calculated, including the 3.84th, 50th (median value), 90th, 95th, and 99th values. Figure 5-1 presents an example probability distribution graph from one of the case study nutrient removal facilities in Iowa Hill, Colorado. Figure 5-1 illustrates the statistical analysis approach utilized in the WEF/WERF investigation to define the 90th percentile effluent concentration performance (0.301 mg/L TP) and the reliability of producing an effluent concentration of 0.05 mg/L (95.7% reliability). Table 5-5 accompanies Figure 5-1 and summarizes the effluent performance statistics and reliability probabilities.

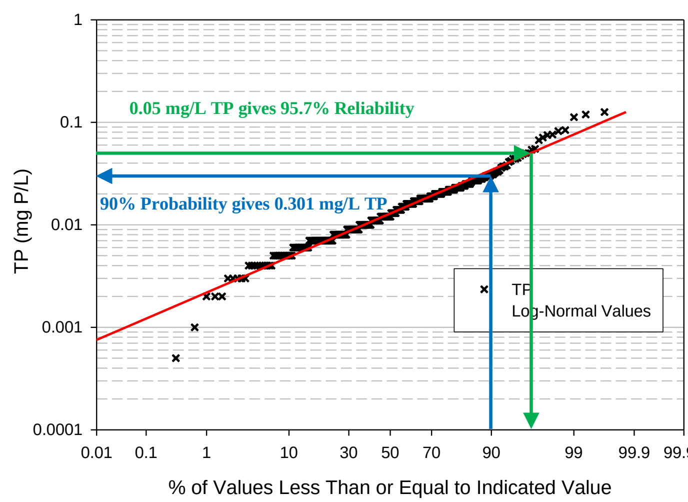

Figure 5-1. Example Probability Plot for Daily TP Data for the Iowa Hill WRF, Breckenridge, CO.
Bott and Parker, 2011.

Table 5-5. TP Probability Values from Percentile Statistics Derived from Data and Calculated TP Reliabilities for the Iowa Hill WRF.
Bott and Parker, 2011.

Probability (%)	TP (mg/L)	Reliability (%)	TP (mg/L)
50	0.0120	39.1	0.010
90	0.0301	71.9	0.020
95	0.0451	86.0	0.030
99	0.0843	95.7	0.050

Note that the Reliability Calculations Assume that the Data are Log-normally Distributed.

While the full distributions were reported for each plant in the plant presentations (Bott and Parker, 2011), the concentrations that were the focus of the technology evaluation corresponding to daily, rolling 30-day average, monthly, and annual averages were the 50th, 90th, 95th and 99th percentile values. To give these values meaning in terms of violations per the five year NPDES permit period, Table 5-6 reports the number of exceedances per permit period for each of these percentile values.

Table 5-6. Number of Exceedances Per Five Year NPDES Permit Period for Daily, Monthly, and Annual Average Permits for Given Percentile Values.
Bott and Parker, 2011.

Percentile Less than Stated Concentration	Daily (with Daily Sampling)	Monthly	Annual Average
Total reporting events in 5 years	**Number of Reporting Events**		
	1,826	60	5
	Number of Exceedances		
50th	912	30	2.5
90th	183	6	0.5 (or 1 per 2 permit periods) [a]
95th	91	3	0.25 (or 1 per 4 permit periods) [a]
99th	18	0.6 (or 1 per 2 permit periods) [a]	0.05 (or 1 per 20 permit periods) [a]

[a] These percentile values can only be calculated assuming the longer periods are adequately represented by 36 months of data.

An important finding in the WEF/WERF investigation was that statistical variability is a characteristic of all of the exemplary plants operating at low effluent nutrient levels and that this variability should be recognized in both evaluation of technologies, as well as considered in the development of appropriate effluent discharge limits. Traditional discharge permits require near 100% reliability in order to avoid noncompliance risks. This study found that deterministic permit limits may not be appropriate for plants achieving very low nutrient limits, particularly when the limit is based on technology (effluent concentration) rather than a water quality-based limit (nutrient load). Further, long averaging periods are appropriate given the inherent variability in the treatment processes used to reduce nitrogen and phosphorus to concentrations approaching zero.

5.4.3 Technology Performance Statistics and Nutrient Speciation

Neethling and Stensel carried the analysis of technology performance statistics a step further to investigate treatment effectiveness for individual nitrogen and phosphorus species (Neethling and Stensel, 2013). An evaluation of the performance of full-scale and pilot-scale wastewater treatment was used to examine processes that are able to remove some nutrient species quickly while other recalcitrant nutrient species remain. Nutrient species that are readily removed by biological and chemical treatment processes includes ammonia, nitrate, nitrite, and phosphate. More complex molecules and soluble organic species react slower and, in some cases, too slow to show measurable reductions in treatment plants. In some cases, the refractory nutrients increase in concentration. The focus of the analysis was to determine the species specific removal efficiencies and reliabilities, and to identify which nutrient species are resisting treatment (i.e., the recalcitrant species) and thereby limiting the ability to reduce nitrogen and phosphorus to lower concentrations.

Neethling and Stensel quantified the performance from conventional and emerging nutrient technologies to remove individual nutrient species at full scale and pilot scale wastewater treatment facilities using the data from other WERF Nutrient Removal Challenge projects (Bott and Parker, 2011; Gu et al., 2012). Gu et al. (2012) measured all of the phosphorus species removed at 12 pilot and full scale treatment facilities of 20 processes or technologies designed to achieve very low phosphorus limits.

5.4.3.1 Reliability and Performance Using Long-Term Data

Neethling and Stensel assessed reliability using full scale data, plotted on probability scale or by rank, to provide a quantifiable measure of reliability. Figure 5-2 illustrates the data analysis of the reliability of achieving low ammonia nitrogen using three years of performance data. The 50th percentile provides an indicator of the average performance of the plant. However, from a reliability perspective, a treatment facility operating under an annual permit limit must perform better than the average; otherwise, it also has a 50% chance of failure. On average, every two years it would exceed the effluent limit. Similarly, while maximum month concentration is represented by the 91.7th percentile (11/12 = 91.7%) a higher reliability is required to meet permit consistently.

Neethling and Stensel used two key statistics to represent reliable treatment: the 80th percentile as representative of the concentration of ammonia that can be achieved on an annual basis with a risk of exceeding it once in a five-year period (20% of five annual values); and the 95th percentile as indicative of a monthly concentration with a risk of exceeding it three times in a five-year period (5% of 60 monthly values). Jimenez, et al. (2007) used the 95% statistic to determine a basis for the reliability of plant performance. These statistics show that the reliable performance for monthly and annual ammonia limits for this facility is 0.10 and 0.17 mg N/L respectively. The average (median) performance of the facility is 0.05 mg N/L, suggesting that there may be room for improved performance if the reliability of the system can be improved.

Figures 5-3 and 5-4 show similar graphics for soluble reactive and for soluble non-reactive phosphorus, respectively, and illustrate the key technology performance statistics: 50th, 80th, and 95th percentiles (Neethling and Stensel, 2013).

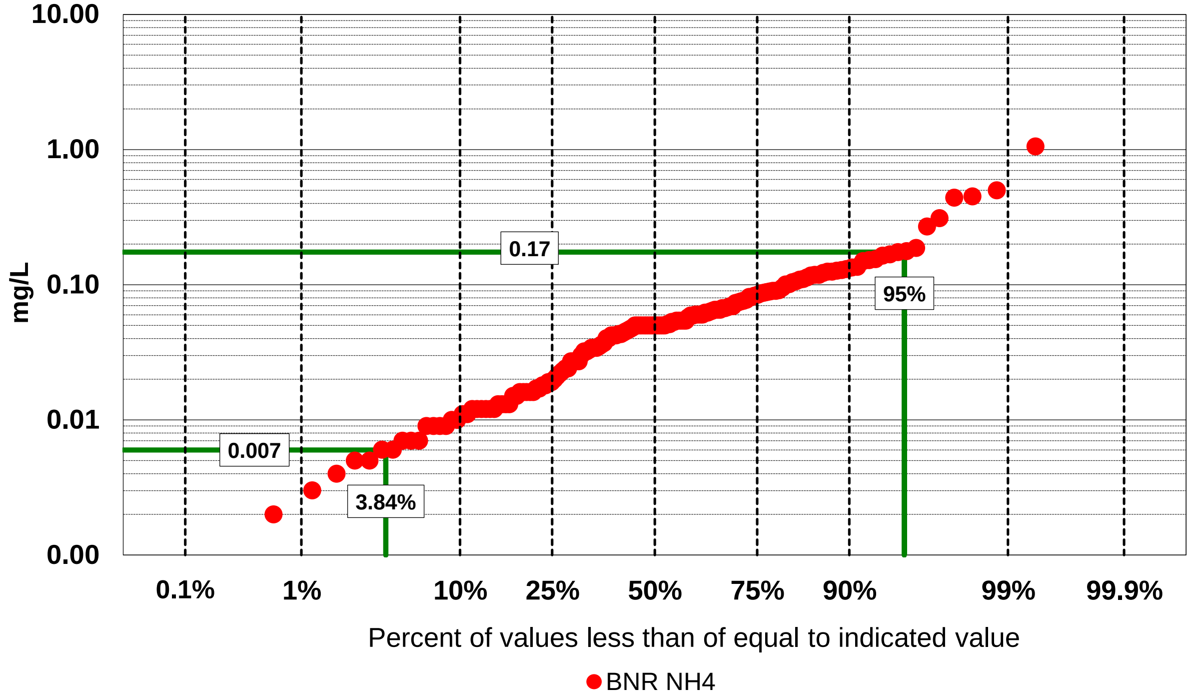

Figure 5-2. Example Statistical Analysis of Ammonia Data Illustrating the Reliable Performance at 80th and 95th Percentiles.
On average, this facility produced a median of 0.05 mg/L (Neethling and Stensel, 2013).

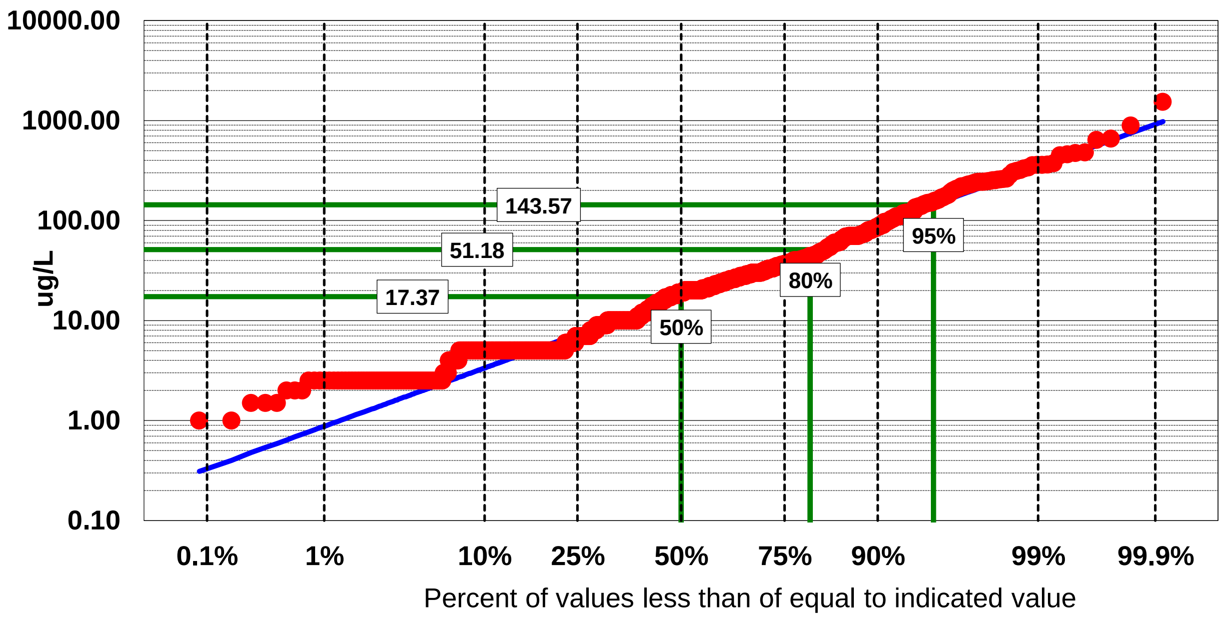

Figure 5-3. Example Statistical Analysis of Soluble Reactive Phosphorus Data Illustrating the Reliable Performance at 80th and 95th Percentiles.
On average, this facility produced a median below 17 ugP/L soluble reactive phosphorus. 25% of the data is below 5 ug/L (Neethling and Stensel, 2013).

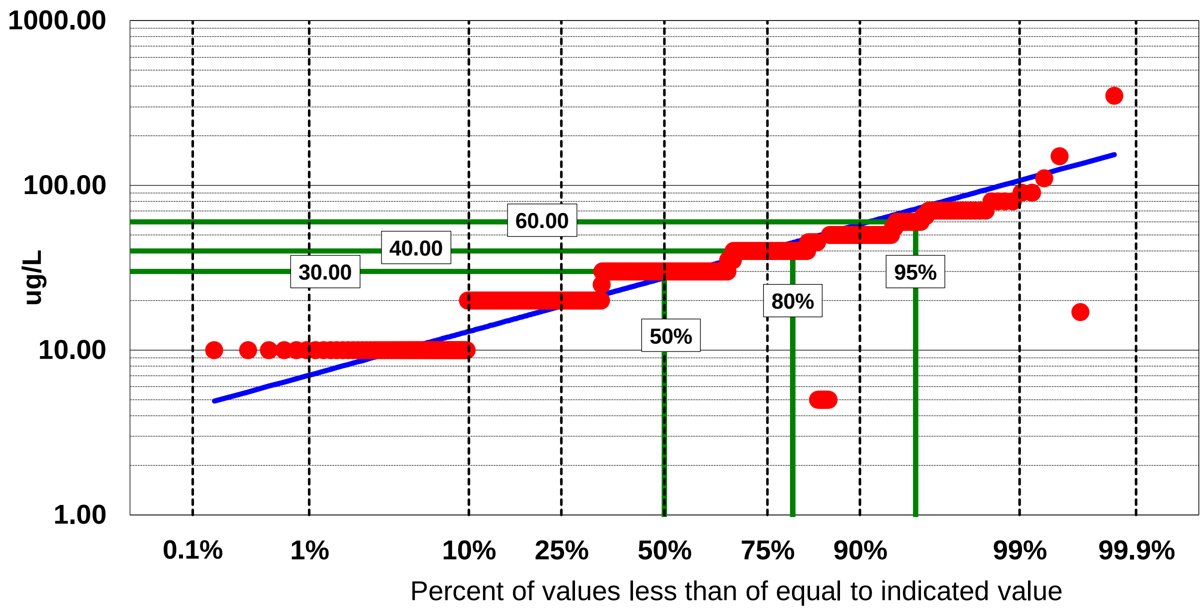

Figure 5-4. Example Statistical Analysis of Soluble Non-Reactive Phosphorus (SNRP) Data Illustrating the Reliable Performance at 80th and 95th Percentiles.

On average, this facility produced a median of 30 ugP/L soluble non-reactive phosphorus (Neethling and Stensel 2013).

5.4.3.2 Long-Term Technology Performance Statistics

Long-term performance statistics for 30 treatment plants for nitrogen species are summarized in Table 5-7 and for phosphorus species in Table 5-8. These results show the technology performance statistics of 50%, 80%, and 95% values for individual nitrogen and phosphorus species.

Nitrogen plants are categorized as follows:

- ♦ BNR plants – biological nitrogen and phosphorus removal using single stage activated sludge in configurations such as A2O and Bardenpho.
- ♦ NDN AS – nitrification/denitrification activated sludge process such as MLE and step feed.
- ♦ Separate stage plants – use separate individual unit processes for nitrification and for denitrification.
- ♦ Addition of carbon for denitrification is noted in table.

Phosphorus plants are categorized as follows:

- ♦ ChemP – plants that uses chemical precipitation for most of the phosphorus removal; typically the chemical is added in a primary clarifier, but occasionally the chemical is added directly to the activated sludge process.
- ♦ BioP – plant that relies on enhanced biological phosphorus removal (EBPR) for most of the phosphorus removal.

- Filter – plants that use filters for tertiary polishing. Additional "chem" indicate chemical additional for additional P precipitation in tertiary process; "floc" and "sed" indicate flocculation and sedimentation also included with tertiary process.
- MBR – membrane bioreactor.

5.4.3.3 Nitrogen Removal

Table 5-7 shows the statistical performance for various technologies used for nitrogen removal of the main nitrogen species: ammonia, NOx, and TN (Neethling and Stensel, 2013). The treatment plants are arranged in order of TN. Additional nitrogen speciation data was collected from selected plants in the reference sources, however these species (organic N, SON, and particulate N) are less frequently measured and consequently less data are available.

The data indicate that the effluent ammonia for some facilities are very low (well below 0.1 mg/L), even at some facilities that do not have an ammonia permit requirement. However, at the reliable range (80 to 95%), the ammonia concentrations increase. Since ammonia limits are often applied to maximum daily samples, it requires higher reliabilities (99%). The data clearly show that the ammonia excursions rapidly increase as the reliability increases. Suspended growth technologies, in particular those with multiple-stage reactors or those operating in warm weather, are able to achieve very low ammonia concentrations.

Some facilities are able to reduce nitrate to very low values; below 1 to 2 mg/L, even at the 80% and 95% reliability level. Facilities that achieve very low nitrate concentrations all use supplemental carbon addition and typically rely on tertiary denitrification processes. The tertiary denitrification process with supplemental carbon addition has an added reliability feature with the ability to adjust the chemical dose.

Table 5-7. Long-Term Data for Nitrogen Removal with Technology Performance Statistics by Species.
Neethling and Stensel, 2013.

Treatment Plant Process	NH4-N (mg/L)			NOx (mg/L)			TN (mg/L)		
	Technology Performance Statistic			Technology Performance Statistic			Technology Performance Statistic		
	50%	80%	95%	50%	80%	95%	50%	80%	95%
NDN AS + Tertiary Denitrification, add Carbon	0.005	0.078	0.24	0.03	0.10	1.15	1.04	1.73	2.71
Separate Stage, add Carbon	0.036	0.083	0.52	0.64	1.2	2.04	1.47	2.18	3.20
Separate Stage, add Carbon	0.05	0.45	2.04	0.1125	0.264	0.54095	1.70	2.38	3.74
BNR	0.17	1.158	2.79						
Tertiary Ammonia removal	0.28	0.4	0.60	0.43	0.74	1.0635	2.50	2.88	3.37
NDN, Carbon added	0.1	0.1	1.68	2.2	2.8	3.8	3.30	4.20	6.20
BNR	0.1	0.99	4.81				3.67	5.19	8.20
BNR, fermenter	0.3	0.73	1.16				4.65	5.25	6.40
NDN AS, add Carbon	0.1	0.1	0.31	3.67	6.39	8.9	4.72	7.72	10.17
NDN AS, add Carbon	0.38	1.31	3.07	3.43	5.09	7.22	5.33	7.13	9.68
BNR				6.635	7.34	7.9545	8.79	11.86	20.45
BNR	0.04	0.06	0.12	9.96	11.808	13.4	10.51	12.31	13.91
BNR	0.049	0.24	2.81						
BNR	0.05	0.1	0.63						
BNR	0.05	0.05	0.34	0.69	1.05	2.15			
BNR	0.06	0.12	1.18						
BNR	0.08	0.08	0.09						
BNR	0.08	0.08	0.28						
BNR	0.1	0.3	0.50						
BNR	0.1525	0.373	1.20						
	1.63	2.32	3.42						

5.4.3.4 Phosphorus Removal

Table 5-8 shows statistical performance for total reactive phosphorus (TRP), total nonreactive phosphorus (TNRP), and TP achievable by various phosphorus removal technologies (Neethling and Stensel, 2013). The treatment plants are arranged in order of total phosphorus.

The data indicate that the TRP concentrations are highly variable. For some facilities TRP concentrations are very low (below 50 ug/L, even approaching 15 to 20 ug/L). Since reactive phosphorus can readily be reduced with chemical addition and effective filtration, the effluent TRP is largely determined by chemical dose and can be adjusted to meet permit requirements at lowest chemical dose.

Soluble Reactive Phosphorus (SRP) can be effectively removed with chemical addition and biological treatment. A treatment plant can control the residual SRP by adjusting the chemical addition to the chemical polishing process. By increasing the dose, SRP can be reduced to very low values. The example data in Figure 5-3 show that the SRP is effectively removed in a full scale plant to a median value below 20 ug/L with 25% of the data below 5 ug/L. This data illustrates the ability to reduce the SRP to low concentrations through chemical addition.

Soluble non-reactive phosphorus (SNRP) is not removed effectively. The data from long-term plant operation in Figure 5-4 show SNRP values ranging from a low of 30 to 60 ug/L, and a high in some cases exceeding 100 ug/L. The significance of SNRP is that the soluble fraction is not amenable to conventional treatment technologies.

Short-term special data can be used to gain an indication of technology performance. The technologies in this survey (Gu et al., 2012) include membrane processes, dual filtration, conventional filters and conventional EBPR plants. Even though the ranking does not provide a reliability measure, the absolute values provide an indication of the expected performance with respect to removal of SNRP. The distribution of the SNRP data indicates that tertiary chemical treatment (floc/sed; filtration) tend to contain less SNRP and that biological treatment only contains a higher SNRP.

SNRP cannot be reduced with conventional treatment. In some cases, the SNRP may increase due to biological production. The special studies show an average SNRP concentration of 10 ug/L. Eighty percent of the samples are below the 15 to 25 ug/L range. The SNRP from a biological process can be on the order of 15 to 50 ug/L.

Particulate phosphorus from special studies underscore the fact that good effluent filtration is capable of reducing pTP. Without filtration the effluent particulate phosphorus is relatively high; but with filtration and in particular, highly efficient filters (dual filters, microfiltration, flocculation/sedimentation/filtration) the particulate fraction can be largely reduced. The data suggest that a pTP concentration between 10 to 20 ug/L should be achievable with filtration; lower levels are possible with membrane filtration or dual filtration to reduce pTP below 5 ug/L.

Table 5-8. Long-Term Data for Phosphorus Removal with Technology Performance Statistics by Species.
Neethling and Stensel, 2013.

Treatment Plant Process	TRP (ug/L) Technology Performance Statistic			TNRP (ug/L) Technology Performance Statistic			TP (ug/L) Technology Performance Statistic		
	50%	80%	95%	50%	80%	95%	50%	80%	95%
ChemP (multiple)	25	25	25	25	55	80	50	80	120
BioP, chem/sed/filter							29	40	54
ChemP (multiple)	40	90	140	35	60	90	70	120	180
ChemP (single, in AS)	90	134	203	17	47	83	71	119	196
BioP, chem/sed/filter	19	44	152	60	78	102	80	116	233
BioP, MBR	50	80	120	30	40	60	80	110	160
BioP, chem/sed/filter	30	57	119	50	71	92	83	113	177
BioP, chem/sed/filter	16	31	141	53	85	169	83	148	329
BioP, filter	40	60	78	80	120	260	110	160	270
BioP, MBR	49	498	2522	11	15	60	51	184	1795
BioP, filter							114	240	480
ChemP (water sludge)	100	300	740	60	100	199	140	310	730
BioP, filter	40	70	110	110	140	180	150	190	324
BioP and ChemP, chem/filter	130	210	810	50	60	150	170	250	950
BioP, filter	100	216	487	80	120	190	190	310	635
BioP, filter	140	210	350	110	140	190	270	350	490
BioP, chem/filter	130	250	610	160	210	304	320	440	770
BioP	105	205	511	177	272	593	340	518	1505
BioP, filter	230	390	642	180	220	290	400	590	890
BioP							423	662	1200
ChemP (single), filter	420	652	950	40	70	140	500	750	972
BioP and chemical							651	1364	1762

5.5 Application of Technology Performance Statistics in Permitting

The following example from Clean Water Services of Washington County, Oregon, illustrates the use of technology performance statistics in nutrient discharge permitting. The effluent discharge permit for the Durham and Rock Creek treatment facilities uses a 50^{th} percentile statistic, or median, for total phosphorous during the summer season. The average effluent phosphorus performance required is defined, as is the reliability of effluent performance.

5.5.1 Clean Water Services of Washington County, Oregon

Clean Water Services (CWS) is a public utility (special services district) that operates four municipal wastewater treatment facilities discharging to the Tualatin River in Oregon. More than 20 small treatment plants in the watershed were consolidated in the mid-1970s into two larger facilities (Rock Creek, Durham), which provide advanced wastewater treatment including phosphorus removal. Oregon’s Department of Environmental Quality (DEQ) issued TMDLs for the Tualatin River for ammonia, phosphorus, temperature, bacteria, and tributary DO. In February 2004, Oregon DEQ issued a single watershed-based, integrated municipal permit to CWS, which is discussed in greater detail in Chapter 8.0.

5.5.2 Median Phosphorus Limits and Effluent Performance

Table 5-9 summarizes the effluent phosphorus requirements in the CWS NPDES permit. Monthly median total phosphorus concentration limits (May – October) are required for the Durham (0.11 mg/L) and Rock Creek (0.10 mg/L) treatment facilities. The phosphorus limits apply seasonally from May 1 to October 31. Use of the median statistic as the basis for the effluent phosphorus limitations allows for the inherent variability in performance to occur without creating a compliance risk. Compliance with the effluent limits in the CWS permit has been successful and resulted in water quality improvements in the Tualatin River.

Table 5-9. Clean Water Services NPDES Permit Phosphorus Limits.

Outfall Number	Parameter	Monthly Median Effluent Concentration
D001 (Durham Facility Outfall)	Total Phosphorus	0.11 mg/L
R001 (Rock Creek Facility Outfall)	Total Phosphorus	0.10 mg/L

The phosphorus reduction period begins May 1 and ends October 31.

Two years of daily effluent total phosphorus data were obtained for the Durham and Rock Creek facilities and the log normal average effluent concentrations were calculated for each year, as shown in Table 5-10 (Reynolds et al., 2005). Effluent from both plants was below the effluent discharge permit limits.

The Durham facility was designed to operate as a biological phosphorus removal plant in either University of Cape Town (UCT) or A^2O process mode and typically operated in A^2O. Alum can be added upstream of the primary, secondary, and tertiary treatment processes to meet the seasonal total phosphorus limit. Daily Durham plant effluent phosphorus data was reviewed from May 10 to October 20, 2004, and from May 9 to July 29, 2005. The log normal mean of the daily effluent data for 2004 was 0.102 mg/L and for 2005 was 0.073 mg/L.

The Rock Creek facility removes phosphorus with alum addition to the primary clarifiers, alum addition followed by chemical clarification, and alum addition followed by multimedia filtration. Daily total phosphorus in the final effluent for years 2004 and 2005 was analyzed and the log normal mean of the daily effluent data for 2004 was 0.082 mg/L and for 2005 was 0.071 mg/L.

Table 5-10. Durham and Rock Creek Phosphorus Performance.
Reynolds, 2005.

Facility	Average Design Flow (mgd)	Recent Average Flow (mgd)	NPDES Total Phosphorus Limit (μg/L)	Final Effluent Log Normal Average Total Phosphorus (μg/L)	
				2004	2005
Durham Facility	25	17	Month median 110 May 1 through October 31	102	73
Rock Creek Facility	34	32	Month median 100 May 1 through October 31	82	71

Summer season daily effluent phosphorus data from the Durham facility is shown in a probability distribution plot in Figure 5-5. The median effluent total phosphorus concentration for the period 2003 through 2005 was 0.060 mg/L, which is well below the median effluent limit of 0.110 mg/L.

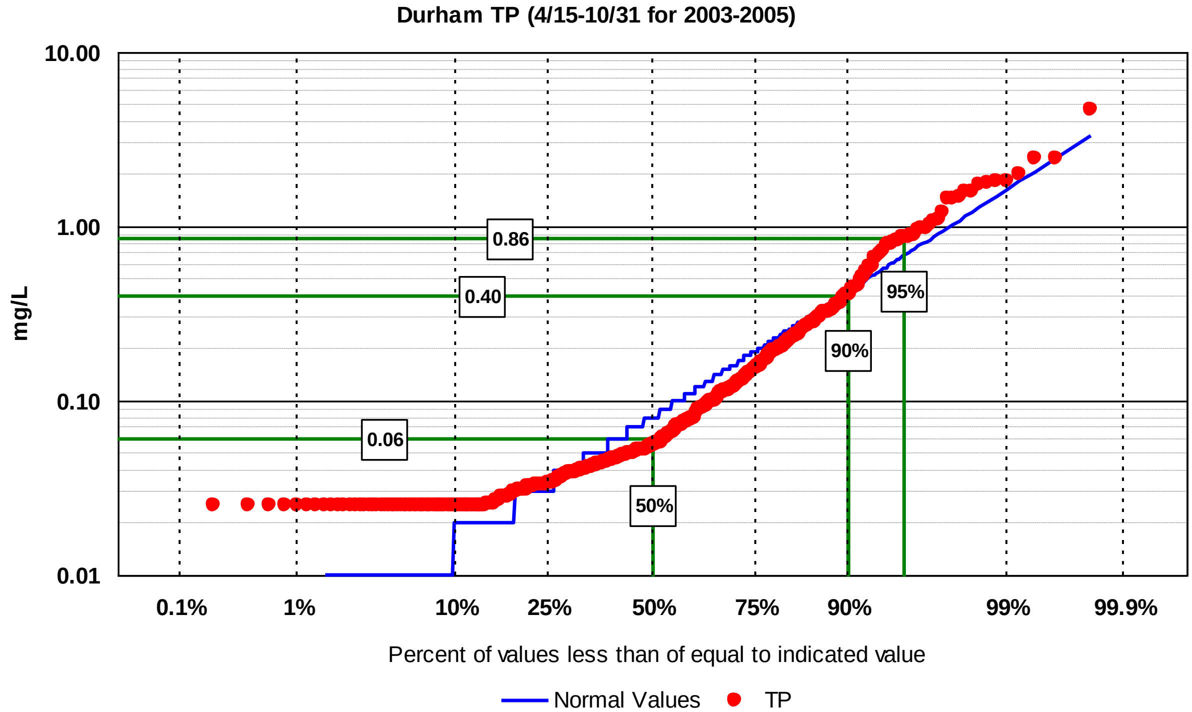

Figure 5-5. Durham Facility Effluent Total Phosphorus, 2003 – 2005.

5.6 Technology Performance Statistics and Policy Recommendations

In 2014, the Johnson Foundation at Wingspread coordinated an initiative titled "*The Road Toward Smarter Nutrient Management in Municipal Water Treatment*" and arranged for a group of interested participants to join a discussion on nutrient management with partners that included WEF and the Environmental Defense Fund (EDF). The group found that the integration of the regulatory environment and opportunities for technical innovation are necessary for advancement in nutrient management. While technology has improved to reduce nutrients in wastewater treatment, to effectively implement this technology requires policies that support its implementation, recognizes the risks, and allows for innovation and interim approaches. "*The conversations remind us that the solutions are not just about technology; change will require appropriate policies, regulations and markets, as well as data and workforce capabilities. All of these pieces need to work together*" to achieve overall improvements in wastewater treatment and watershed water quality (The Johnson Foundation at Wingspread, 2014).

Given the state of technology, the group thought that many facilities have opportunities to reduce their nutrient loads through relatively straightforward measures at low costs, i.e., the first step concept, yet the regulatory conditions are not supportive of such undertakings. The conclusions from the Johnson Foundation discussion were as follows (The Johnson Foundation at Wingspread, 2014):

- Encourage utilities with less regulatory pressure to adopt the pioneering practices that highly regulated WRRFs are undertaking.
- Identify innovative solutions to the difficulties regulated facilities face in cost-effectively meeting permitting requirements.
- Address tensions between the desire to reduce nitrogen loads overall while also allowing for capacity to meet population growth demands.
- Anticipate the establishment of new or more-stringent regulatory requirements.
- Explore opportunities for low-cost efforts, especially those that can reduce operational costs (e.g., adding anaerobic denitrification to systems that nitrify ammonia to nitrate earlier in the treatment process).

Owners and operators of treatment facilities are underneath a regulatory environment that creates disincentives to take on risks in the interest of reducing nutrients. Regulatory practices that could help to alleviate these disincentives include the following (The Johnson Foundation at Wingspread, 2014):

- Safe harbor programs, i.e., voluntary programs that allow for experimentation with or the piloting of new or innovative approaches with limits on the regulatory disincentives or risks.
- Stochastic permitting, which uses probability models to consider fluctuating pollutants over relatively long periods of time, rather than using highly prescribed, inflexible limits enforced on a weekly or daily basis.
- Approaches to allow temporary use of current excess permitted capacity for cost-effective enhanced treatment, without triggering lower effluent discharge requirements.

5.6.1 Interim Limits and Adaptive Management

Use of technology performance statistics alone may provide at a minimum an interim approach until achieving a greater understanding of the inter-dynamics of the facility performance and discharge with the receiving water. An interim approach also provides opportunities to assess and determine better overall watershed solutions that cost less, do more, and don't waste energy, generate a lot of adverse environmental effects like greenhouse gas emissions (GHGs), excessive chemical use and extra sludge.

This interim approach fits with the existing regulatory framework. For example, compliance schedules are one of the regulatory tools that current exists and can be used. The interim approach uses a strategy of not trying to accomplish everything all at one time. Instead allow facilities time to implement technologies in stages to step down to lower nutrient concentrations. Compliance schedules can be used when states pursue rulemaking for numeric nutrient standards and include technology-based limits for the first step – such as effluent limits of 1 mg/L TP and 10 mg/L TN – its affordable and relatively easy to accomplish and results in a significant reduction in point source nutrients that is achieved with the first step.

The interim approach is an alternative to trying to go to the final low in-stream concentration endpoints in one permit cycle. Permit writers that attempt to write the first permit to reconcile with WQBELs are often met with wastewater utility resistance because the relationships between nutrients and receiving water quality are too uncertain to be relied upon to make expensive financial investments. With the interim approach using multiple steps, all parties can work to solve the water quality issues in an adaptive management approach. Proper implementation of adaptive management allows everyone to learn more about the treatment options, capabilities, and impacts on receiving water. A compliance schedule provides the opportunity to do that and optimize the overall approach to nutrient management. The interim approach has the following benefits:

- Time to figure out how well the treatment plant can be operated and how far the loadings compared to the design criteria can be optimized.
- Time to figure out how the receiving water responds to the reduced nutrient loading; the stressor-response relationship.
- Overall, the adaptive management approach may provide a more optimal nutrient management plan for a watershed that costs less than the push for limit of technology point source treatment from the outset.

CHAPTER 6.0

PREDICTIVE WATER QUALITY MODELS AND PERMITTING

Predictive water quality models are tools used to estimate future receiving water conditions based on historical information and scientific relationships. A number of water quality models are available of varying complexity and capabilities for the simulation of water quality. Many of these models are based on quantitative relationships between nutrients, site-specific water quality, and ecological response indicators (dissolved oxygen, pH, algae). Process-based load-response models use mathematical representations that link nutrient loads to in situ water quality and/or ecological responses. Examples are the relationships between nutrients, light, and water temperature to the growth rate of algae. Models with these capabilities are well known and include AQUATOX, CE-QUAL-W2, QUAL2K, and WASP (Bierman et al., 2013). These models are capable of generating a significant amount of output (data) from a simulation. This information can be valuable in understanding the dynamics of a receiving waterbody. Since the purpose of discharge permitting is to limit the pollutants discharged to the receiving water to protect beneficial uses, the information from predictive models can be useful in developing discharge permits. Further, water quality models are tools that can be used to investigate a variety of potentially acceptable discharge permit conditions to find the most technically feasible, economical, and sustainable means of achieving compliance.

This chapter presents a discussion of predictive water quality models and their potential applications in effluent discharge permitting. Wastewater discharges used as input to water quality model simulations of future conditions may be based on the technology performance statistics discussed in Chapter 5.0 to provide a realistic portrayal of future conditions with nutrient removal. Chapter 7.0 presents a discussion of on the use of probability analysis in consideration of variability in receiving water conditions.

6.1 Application of Water Quality Models

Water quality models are powerful tools that can provide significant insights into receiving water conditions and the impacts of wastewater discharges and other nutrient loading sources on water quality. A number of water quality models of varying complexity and capabilities are available for simulation of water quality. Many of these models include quantitative relationships between nutrients, site-specific water quality, and ecological response indicators (dissolved oxygen, pH, algae). Process-based load-response models use mathematical representations that link nutrient loads to in situ water quality and/or ecological responses. Examples are the relationships between nutrients, light, and water temperature to the growth rate of algae. Models with these capabilities are well known and include AQUATOX, CE-QUAL-W2, QUAL2K, and WASP (Bierman et al., 2013). These models are capable of generating a significant amount of output (data) from simulations that can be used in formulating effluent discharge permits.

6.1.1 Benefits and Limitations

In some cases, the application of water quality models to inform discharge permitting is limited because modeling requires more resources (data, time, funding, expertise, etc.) than simpler permitting methods. In other circumstances, water quality modeling may be used in watershed analyses and TMDLs that are prepared prior to revisions in discharge permits. If permitting scenarios are not explored during a watershed analysis or TMDL, the water quality model may not be used by the permitting entity for any number of reasons including lack of budget resources, lack of modeling skills, lack of sufficient time to meet permit renewal deadlines, etc.

Applying water quality models to receiving waters and using models to inform permitting may be complex and requires adequate budget and schedule resources. Model selection, set-up, calibration, and interpretation of modeling results are potentially complex and time consuming. Each step in the predictive modeling process has hurdles to overcome, as well as the need to reach consensus among stakeholders regarding the model and interpretation of its results.

Nevertheless, these challenges may be relatively small in comparison to the implications of the capital and operating investments required of wastewater treatment facilities which are subject to the compliance requirements of effluent discharge permits. Therefore, the investment of time and resources necessary to utilize water quality models as predictive tools to inform discharge permitting may be well justified.

6.1.1.1 Benefits

Benefits of the use of water quality models to inform nutrient discharge permitting are summarized as follows:

- ♦ Supports the use of science-based relationships between nutrient loadings and water quality response indicators (DO, pH, algae).
- ♦ Ability to simulate alternative nutrient management scenarios, including alternative permit limits.
- ♦ Ability to employ dynamic simulations to evaluate seasonal loading scenarios and other time variable alternatives for discharge permitting.
- ♦ Allows for site-specific simulations to tailor discharge permit limits to unique local conditions.
- ♦ Avoids reliance on nitrogen and phosphorus concentrations such as numeric nutrient criteria, eco-region criteria, etc., in WQBELs.

6.1.1.2 Limitations

Limitations of the use of water quality models to inform nutrient discharge permitting are summarized as follows:

- ♦ Availability of water quality monitoring data to support model development.
- ♦ Availability of water quality modeling skills.
- ♦ Availability of adequate budget and schedule resources for model selection, set-up, calibration, and scenario simulation.

6.1.2 Simplified Example

In this simplified example of the application of water quality modeling in discharge permitting, a typical secondary treatment facility is assumed to discharge 10 mgd (15.5cfs) to surface waters with a low flow of 1,550 cfs. Receiving water quality requirements dictate that reductions in phosphorus be made to address beneficial use impairments (303(d) listings) identified as chlorophyll a, DO, and pH. The TMDL applied a commonly used and accepted water quality model to simulate the water quality response to nutrient loadings that meet targets for chlorophyll-a, DO, and pH. The TMDL modeling analysis led to the conclusion that wasteload allocations based on TP of 0.100 mg/l were necessary.

When the NPDES permit is to be renewed, the permit writer uses the TMDL to inform the analysis for determining effluent limitations. The TMDL identified the impairment, provided the results of a predictive water quality model, and established a wasteload allocation. These are informative, but the permit writer still has a variety of options to consider in the formulation of the discharge permit effluent limits.

The traditional deterministic approach to discharge permitting may result in the most restrictive and inflexible effluent limits. Table 6-1 illustrates this result with effluent phosphorus limits for both concentration and mass included in the permit for both monthly and weekly durations. The monthly concentrations are set equal to the TMDL wasteload allocation total phosphorus target of 0.100 mg/l. The weekly limits are assumed by the permit writer to be set at some ratio upon the monthly limits. The monthly and weekly mass limits are set using the concentration and facility flow rate.

The issues introduced in this example permit include the potential for the effluent limits to be unnecessarily inflexible. It may not be necessary to have monthly and weekly limits for both mass and concentration to meet the requirements of the TMDL and be protective of water quality. The water quality model can be used to simulate more flexible effluent limit structures and evaluate if they are equally protective of water quality while being flexible enough to facilitate compliance.

Table 6-1. Example of Final Effluent Limitations Based on Traditional Deterministic Approach.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Average Monthly Limit**	**Average Weekly Limit**	**Maximum Daily Limit**
Total Phosphorus as P	mg/l	0.1	0.15	–
	lb/day	8.3	12.5	–

Alternatively, since the impairment is for chlorophyll a, DO, and pH, as opposed to exclusively the phosphorus concentration itself, the water quality model can be used as the basis for more flexible effluent limits. The model may show that attenuation occurs between the discharge point and the TMDL compliance point at a downstream location, and that the effluent concentration at the outfall is not important. Since phosphorus is a nutrient, not a toxic, the longer term water quality impacts warrant more flexible monthly average mass limits for phosphorus, as illustrated in Table 6-2. The advantage of this permit formulation is that it facilitates successful compliance by avoiding unnecessary concentration limits that might be exceeded in the normal variability in effluent phosphorus from a nutrient removal facility.

Table 6-2. Example of Final Effluent Limitations Based on Monthly Mass.

Final Effluent Limits – Outfall 001		
Parameter	**Units**	**Monthly Average Limit**
Total Phosphorus as P	lb/day	8.3

Examining the modeling and TMDL further may reveal that phosphorus control in the off-season may not provide additional water quality benefits, and the effluent limitations could be further refined to a seasonal average during the growing season, as shown in Table 6-3. This is based on model simulations showing attenuation between the discharge point and the TMDL compliance point at a downstream location, along with the lack of impact on the other impairment parameters during the non-growing season. Since the modeling and the permit writer's calculations show phosphorus has impacts over the growing season, a seasonal average mass limitation is selected as the effluent limit.

The advantage of this permit formulation is that it provides flexibility for achieving compliance in multiple ways. Nutrient removal treatment might be combined with other watershed best management practices to reduce nonpoint sources that satisfy the seasonal mass loading limit. This may foster other beneficial watershed management activities through water quality offsets or trading.

Table 6-3. Example of Final Effluent Limitations Based on Seasonal Average Mass.

Final Effluent Limits – Outfall 001		
Parameter	**Units**	**Seasonal[1] Average Limit**
Total Phosphorus as P	lbs	1,276
[1]Seasonal defined as May 1 through September 30		

These are three possible alternatives for developing the final effluent limitations for discharge permitting. Each requires sufficient information be presented in the TMDL and from the predictive water quality modeling for the permit writer to translate the information provided into the permit structure. Other creative permitting results, such as time variable or extended period simulations, could also be incorporated into the water quality assessment and final effluent limitations structure based on the available information and the simulation of water quality dynamics.

6.2 Traditional Approaches Used to Inform Permitting

Although predictive models are powerful analytical tools, they are not typically used as part of the discharge permitting process. More commonly, the method used for setting nutrient effluent limitations for discharge permits reverts to the calculation of WQBELs focused on an effluent mixing zone following guidance from the TSD Water Quality-Based Toxics Control (U.S. EPA, 1991). This approach limits the unique consideration of nutrient impacts on water quality in the broader watershed and narrows the consideration to the near field mixing zone. This method is simplistic in that the most conservative scenario is assumed and values that represent those conditions are used in an algebraic equation to calculate allowable effluent limits. Information about variability in effluent concentrations, treatment efficiency and reliability, temporal and spatial variability of the receiving water, risk of exceedance, cause and effect, and water quality response are excluded from consideration using this method.

This traditional permitting approach is based on principles for water quality-based effluent limits. These are primarily linked to guidance based on controlling aquatic toxicity. There is a limited mixing zone focus, as opposed to a broader watershed scale, with a back calculation to the end-of-pipe discharge from the edge of the mixing zone. The approach typically relies on combining multiple conservative assumptions for the selection of values used in the analysis. In some cases, even when a predictive water quality model was used to develop the wasteload allocation in a TMDL and is available for use, it is not used to customize permitting in ways that maximize flexibility for successful compliance. The traditional approach may simply extract the wasteload allocation from the water quality modeling effort and combine it with the most conservative assumptions for receiving water conditions and use standard equations to arrive at monthly and weekly effluent limits.

6.3 EPA Guidance on Water Quality-Based Effluent Limits

EPA developed guidance for permit writers on water quality-based effluent limits (U.S. U.S. EPA, 2010) that references the approach recommended in EPA's *TSD for Water Quality-based Toxics Control* (U.S. EPA, 1991). The EPA permit writers' guidance recognizes that for non-conservative pollutants, such as nutrients, that the steady state assumptions may be inappropriate and that more sophisticated water quality models may be more appropriate, as in the following:

"As with the reasonable potential assessment, the type of steady-state model used to determine a WLA depends on the type of mixing that occurs in the receiving water and the type of pollutant or parameter being modeled. As discussed in Section 6.3.2 above, permit writers can use the mass-balance equation as a simple steady-state model for many pollutants, <u>such as most toxic (priority) pollutants or any pollutant that can be treated as a conservative pollutant when considering near-field effects</u>, if there is rapid and complete mixing in the receiving water. <u>For pollutants or discharge situations that do not have those characteristics (e.g., non-conservative pollutants, concern about effects on a downstream waterbody), a water quality model other than the mass-balance equation would likely be more appropriate</u>" (U.S. EPA, 2010).

Nutrients are non-conservative pollutants and in most cases, the water quality concerns are for downstream effects beyond the near field mixing zone. For these circumstances, the EPA permit writers' guidance recommends that more sophisticated water quality models beyond mass balance equations are more appropriate for permitting.

6.4 Considerations in the Application of Water Quality Models

Water quality models are powerful tools that are capable of aiding and enhancing the development of nutrient permits. Predictive models can provide significant insights in many different ways as part of a more comprehensive approach to permitting that allows for the consideration of variability in treatment performance and effluent quality, variability in receiving water flow and water quality conditions, and the objectives for overall environmental health of the watershed.

Predictive models have been developed and are available for application to a wide range of waterbody types and water quality conditions. When applied appropriately, these models have the ability to predict the probability of water quality conditions with a high level of confidence. However, the application of water quality models to site-specific conditions has limitations due to the model framework, the available data, and knowledge about the site used to construct the model. As a broad generality, the capabilities of models for dissolved oxygen, phytoplankton, water clarity, attached algae, and pH are often more limited by the availability of site-specific data than by inherent limitations in the model conceptual or operational frameworks (Bierman et al., 2013).

Principal limitations of water quality models commonly used may be categorized as follows: nutrient loadings, state variables, ambient processes, harmful algae blooms, model uncertainty, submerged aquatic vegetation, macroinvertebrates, fish, and ecosystem structure and function (Bierman et al., 2013). These limitations are generally due to a lack of site-specific data or understanding of fundamental processes. Selecting the appropriate model that incorporates the available site-specific data and has the capability to represent the processes occurring is important for minimizing these limitations.

Predictive water quality models are able to represent many waterbodies and the influence of sources on the water quality to provide valuable information to support the permitting process. However, while models have significant capabilities, there are limitations. “Model credibility is best enhanced by fully communicating the nature and limitations of the modeling. This is best facilitated by comprehensive documentation, including clear descriptions of all aspects of the modeling process” as providing enough information is a critical part of the permitting process (Bierman et al., 2013). Limitations exist simply due to the complexity of nature that is being influenced by anthropogenic inputs from point sources. Recognizing these and incorporating this uncertainty into the analysis as best as possible with the available tools is recognized as the appropriate approach for water quality management. The opposite approach “wherein only selected inputs and results are provided, is inappropriate for regulatory application” (Bierman et al., 2013). While the application of water quality models has limitations, these can be pointed out and addressed such that the benefits of water quality modeling may be used to inform nutrient discharge permitting.

Another aspect of applying water quality models is a practical limitation, especially for more complex models. The model user must be able to appropriately pre-process site-specific input data to construct the model and post-process model outputs for appropriate interpretation. Post-processing the data in a manner that is informative is particularly important. The model may generate strings of data in a text file that must be extracted from this file and presented in a tabular or graphic form that can be shared with a stakeholder audience for interpretation. This step is the one of the most valuable aspects of the water quality analysis since it informs the discharge permitting process.

6.5 Application of Water Quality Models for Permit Scenario Simulations

The simplest application of a water quality model, likely developed for a TMDL, is to use that model to test potential alternative discharge permit scenarios. A scenario may be developed based on the preferred treatment options to satisfy the wasteload allocation for the point sources and the expected performance of the BMPs to be employed to meet the nonpoint source load allocation. The scenarios can be entered into the model and simulated, the results evaluated, and then compared to the water quality standards. The scenarios may be simple, such as setting all sources at a constant value, or more complex. Complex scenarios may have point sources set at one target value for nutrient reduction, and nonpoint sources at another value, or potentially with each source varying by season, location, or other factors. Instead of using a single constant value to represent the nutrient management scenario, a time series with variability may be used from the future management plan. This may be a more realistic portrayal of expected future conditions. Providing there are adequate resources available to perform these types of test scenarios, multiple scenarios may be simulated using the water quality model until a satisfactory combination of point and nonpoint source controls is ascertained and satisfactory to stakeholders. The result can then serve as the basis for nutrient discharge permitting.

The following sections describe the application of water quality models to the development of effluent discharge permit limits for nutrients. The case study examples presented here cover a range of scenarios to illustrate the use of models in a variety of situations. Some are simplistic in that the model scenarios lead directly to effluent discharge limits for nutrients. Others are somewhat more complex and include examples of the use of water quality models to simulate alternative effluent limits and structure discharge permits to match.

6.5.1 Snake River Hells Canyon TMDL and Phosphorus Concentration Limits

The Snake River Hells Canyon TMDL extends from where the Snake River intersects the Oregon/Idaho border near Adrian, Oregon, to immediately upstream of the inflow of the Salmon River (RM 188). The TMDL was been developed to comply with Idaho and Oregon's responsibilities within the CWA and state-specific TMDL schedules. The Snake River is listed as impaired from river mile (RM) 409 to 272.5 for nutrients. Available data show that excessive total phosphorus concentrations have led to nuisance algae blooms that have been observed to occur routinely.

A dynamic simulation water quality model, CE-QUAL-W2, was used to evaluate water quality conditions. The model was used to simulate the water quality response to a target concentration of 0.07 mg/l total phosphorus. Modeled chlorophyll a concentrations resulting from the attainment of the 0.07 mg/l total phosphorus target are within the range representing valid maxima for support of aesthetic and recreational designated uses. While substantial improvements in dissolved oxygen are projected to occur as a result of the attainment of the 0.07 mg/l total phosphorus target, additional improvements were also determined to be necessary to meet the dissolved oxygen criteria in the downstream reservoir.

Site-specific chlorophyll a and total phosphorus targets (less than 14 ug/l and less than or equal to 0.07 mg/l respectively) were identified in the TMDL. Inflowing tributaries have been assigned load allocations to meet the 0.07 mg/l total phosphorus target at their inflow to the Snake River, including the Lower Boise River. As a result, the total phosphorus 0.07 mg/l concentration target has been used by permit writer's to develop permit limits for wastewater treatment plant discharges to the Lower Boise River.

6.5.1.1 City of Kuna Effluent Phosphorus Limits

The City of Kuna, Idaho, discharges to Indian Creek, which subsequently flows to the Lower Boise River which is tributary to the Snake River and subject to the Snake River Hells Canyon TMDL. The elevated phosphorous concentration in the Boise River contributes to the impairment of the Snake River. The downstream TMDL calls for a reduction in phosphorous loading to the Snake River from the Boise River and other tributaries during a critical season (May 1st through September 30th) to meet the Boise River tributary load allocation of less than or equal to 70 μg/l, under all flow conditions. The Lower Boise River is highly enriched with phosphorous, with concentrations as high as 0.5 mg/l (500 μg/l) at Parma, ID and as high as 0.8 mg/l (800 μg/l) at Middleton, ID. Ambient data compiled from several U.S. Geological Survey (USGS) monitoring locations on Indian Creek where the City of Kuna discharges show a 95^{th} percentile phosphorus concentration of 0.77 mg/l (770 μg/l) and an average phosphorus concentration of 0.514 mg/l (514 μg/l). No assimilative capacity for phosphorus is available in Indian Creek or the Boise River because ambient concentrations are far above the Snake River TMDL target. Therefore, the City of Kuna's discharge permit has been structured to base effluent limits on the Snake River Hells Canyon TMDL load allocation for tributaries of 0.070 mg/l, as shown in Table 6-4.

The City of Kuna discharge permit was prepared by EPA and the permit writer included weekly phosphorus concentration limits and mass loading limits. Since there was not effluent monitoring data available at low phosphorus concentration levels to inform permitting, assumptions were made by the permit writer, as follows:

"Since effluents are not constant, the average weekly discharge limitation is numerically greater than the average monthly discharge limitation. EPA has calculated an average weekly limit of 105 µg/l by using the same ratio of the average weekly limit to the average monthly limit as used in the "secondary treatment" technology-based limits for BOD and TSS (1.5:1). The average weekly limit was calculated in this manner because facility specific effluent data are not available, and EPA determined in the analysis supporting the secondary treatment effluent limits that the 1.5:1 ratio is representative of typical effluent variability for POTWs."

"While EPA believes a concentration limit for phosphorus is necessary in this case to prevent the discharge from contributing to an excursion above water quality standards, the federal regulation 40 CFR 122.45(f) requires that effluent limits be expressed in terms of mass, and allows limits to be expressed in terms of other units of measurements in addition to mass. Therefore the permit contains both mass and concentration limits, and the permittee is required to comply with both the mass and concentration limits. Mass limits were calculated from the concentration limits based on the maximum month design flow of the WWTP, consistent with 40 CFR 122.45(b)(1)."

Table 6-4. City of Kuna, Idaho NPDES Permit Limits for Phosphorus.
U.S. EPA, 2009.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Average Monthly Limit**	**Average Weekly Limit**	**Maximum Daily Limit**
Total Phosphorus as P	ug/l	70	105	Report
(May 1 – September 30)	lb/day	See I.B.2.		Report
Section I.B.2. Phosphorus offset plan and phosphorus mass limits: Prior to discharging more than 1.1 lb/day of total phosphorus on a monthly average basis or more than 1.65 lb/day of total phosphorus on a weekly average basis during the season of May 1st through September 30th, the permittee must submit to EPA a plan that describes how the permittee will comply with IDAPA 58.01.02.054.04, including written documentation of IDEQ's approval of the plan.				

6.5.2 Wenatchee River TMDL and Phosphorus Concentration Limits

The Wenatchee River in eastern Washington is subject to a Watershed Dissolved Oxygen, pH and Phosphorus TMDL Study published in 2006. This study was based on intensive water quality monitoring from 2002 to 2004. Washington Department of Ecology concluded the observed data showed dissolved oxygen and pH impairments in the Wenatchee River below Leavenworth, WA. The dissolved oxygen and pH impairments in the Wenatchee River were determined to be caused by excessive periphyton growth. Furthermore, phosphorus was determined to be the most limiting nutrient controlling periphyton growth. A mass balance of phosphorus loading sources was determined for the Wenatchee River by using the QUAL2K water quality model.

The water quality analysis applied a steady state QUAL2K model that revealed that compliance with the water quality standard for pH was a more stringent requirement than compliance with dissolved oxygen standards. The QUAL2K model was used to establish phosphorus waste load allocations and load allocations to meet the TMDL capacity. The water quality simulations showed that there was no remaining capacity for additional phosphorus loadings to the river. Existing point source discharge levels of phosphorus are to be held to a level that does not cause a cumulative, measurable change in pH, established as less than a 0.1 pH unit change from the natural condition pH range in any part of the river. Existing point sources would only be allowed to continue to discharge if they had a “de minimus” or “no measurable” affect. The result was a phosphorus wasteload allocation of 0.09 mg/l based on pH.

6.5.2.1 City of Leavenworth Effluent Phosphorus Limits

The TMDL has resulted in compliance schedules for the existing point source dischargers with new effluent limits for phosphorus to take effect in the future. For example, the City of Leavenworth’s discharge permit includes the following compliance schedule in Section 9 (Washington DOE, 2010a):

“S9. COMPLIANCE SCHEDULE

The Permittee must meet the schedule requirements listed below in order to comply with a total phosphorous wasteload allocation contained in The Wenatchee River Watershed DO and pH TMDL Water Quality Improvement Report. The waste load expressed as a concentration is 90 μg/l or at full flow design criteria a maximum load of 0.286 kg/Day total phosphorous.

A. Schedule of TMDL Compliance

The Permittee must comply with the TMDL assigned phosphorus wasteload allocation no later than ***the permit cycle ending of in 2020.”***

6.5.3 Clark Fork River and Nutrient Loading Limits

In-stream nutrient targets for the Clark Fork River in western Montana and basin wide nutrient source reduction objectives were developed as part of the Voluntary Nutrient Reduction Program (VNRP) (Tri-State, 1998). This was the equivalent to a TMDL for the Clark Fork River. A goal was to restore beneficial uses and reduce nuisance algae growth in the river. The targets selected to achieve this goal were chlorophyll a of 100 mg/m2 (summer mean) and 150 mg/m2 (peak), total phosphorus of 20 μg/l upstream of Missoula, MT and 39 μg/l downstream, and total nitrogen of 300 μg/l.

Water quality model simulations were used to test alternative scenarios and the predicted river conditions. The Clark Fork River water quality model was developed using spreadsheets and QUAL2E (later converted to QUAL2K) to represent nutrient concentrations in the river and to estimate the reductions in effluent nutrient loading needed to meet the targets. Model simulations were made with a variety of assumptions to conduct the TMDL analysis and arrive at the final wasteload allocations and load allocations.

- Model Run A: Calibration run of the Clark Fork River under summer conditions.
- Model Run B: Clark Fork River 30Q10 flows with no nutrient controls in place.
- Model Run C: Clark Fork River 30Q10 flows with Voluntary Nutrient Reduction Plan (VNRP) reductions in place, including point source nutrient removal wastewater treatment and nonpoint source reductions by septic system abatement and sewer extensions.

Nutrient management scenarios that were modeled included combinations of both point source and non-point source reductions. Investigations led to the recognition that reductions were necessary from key point sources, smaller point sources, septic systems, non-point sources, and new/growth related sources to meet these goals. For the key point source discharge to the Clark Fork River, the City of Missoula, treatment facilities were expected to meet effluent levels of 1 mg/l total phosphorus and 10 mg/l total nitrogen. Other point source dischargers were to avoid discharging during the summer season (Stone Container Corporation and Deer Lodge, MT). While these levels are essentially technology-based effluent limits, combining these with prioritized and feasible reductions from other sources, such as septic system abatement to reduce nonpoint source nutrient loadings, it was possible to use the water quality model to show that the TMDL could be satisfied at these effluent concentration levels.

6.5.3.1 City of Missoula Effluent Nitrogen and Phosphorus Limits

The Clark Fork River modeling resulted in a nutrient management plan with summer season nutrient loading limits for the City of Missoula, combined with zero discharge from other point sources, and a nonpoint source load reduction from extension of sewer service from the City to an unsewered area along Mullan Road. The Mullan Road sewer extension resulted in a nutrient load reduction through elimination of approximately 5,000 septic systems. The City of Missoula effluent discharge permit with seasonal nitrogen and phosphorus mass loading limits linked to the Clark Fork River VNRP is shown in Table 6-5.

Table 6-5. City of Missoula Discharge Permit Nutrient Limits.
Montana DEQ, 2006.

Parameter	Units	Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit
Total Nitrogen	lb/day	–	–	888.8
Total Phosphorus	lb/day	–	–	88

Nutrient limitations apply from June 1 through September 30.

6.5.4 Spokane River DO TMDL and Seasonal Mass Phosphorus Limits

The Spokane River and Lake Spokane Dissolved Oxygen TMDL: Water Quality Improvement Report (Washington DOE, 2010b) established wasteload allocations for total phosphorus, $CBOD_5$, and ammonia nitrogen for each wastewater discharger to the Spokane River. The CE-QUAL-W2 dynamic water quality model was used as the tool to understand the complex water quality conditions and conduct analyses to quantify the relationship between these constituents in the Spokane River (PSU, 2010). For the TMDL, dissolved oxygen in Lake Spokane is volume weighted in the reservoir from the model segmentation. The small difference between the dissolved oxygen profile for the natural condition in the reservoir and the TMDL wasteload condition is a cumulative allowable 0.2 mg/l DO depression for compliance with Washington water quality standards. This results in a very restrictive TMDL.

In 2010, the Spokane River TMDL was finalized with a scenario based on very low effluent CBOD (4.2 mg/l), ammonia nitrogen (0.21 mg/l), and total phosphorus (0.042 mg/l) wasteload allocations, as summarized in Table 6-5.

Table 6-6. Spokane River DO TMDL Wasteload Allocations for Washington Dischargers.
Washington DOE, 2010b.

Discharger 2027 Projected Flow Rates	Ammonia Nitrogen		Total Phosphorus		CBOD5	
	mg/l	**lbs/day (WLA)**	**mg/l**	**lbs/day (WLA)**	**mg/L**	**lbs/day (WLA)**
Liberty Lake Sewer District (1.5 mgd)	March-May, October: 0.71 mg/l June-September: 0.18 mg/l		0.036	0.45	3.6	45.1
Kaiser (15.4 mgd)	0.07	9.0	0.025	3.21	3.6	462.7
Inland Empire Paper Company (4.1 mgd)	0.71	24.29	0.036	1.23	3.6	123.2
City of Spokane (50.8 mgd)	March-May, October: 0.83 mg/l June-September: 0.21 mg/l		0.042	17.81	4.2	1,780.6
Spokane County (8 mgd)	March-May, October: 0.83 mg/l June-September: 0.21 mg/l		0.042	2.80	4.2	280.4
Stormwater (2.36 mgd)	0.05	0.98	0.310	6.1	3.0	59.1
Combined Sewer Overflow (CSO)(0.12 mgd)	1.0	1.0	0.95	0.95	30.0	30.3

6.5.4.1 Analysis for Seasonal Limits Loading Limits

Federal regulations require that effluent limits for POTWs be calculated based on the design flow of the POTW (40 CFR 122.45(b)(1)) and that effluent limits for POTWs generally be expressed as average weekly and average monthly discharge limitations, unless impracticable. The basis for expressing effluent limits for TP, ammonia and CBOD as seasonal average limits is based upon the memorandum dated March 3, 2004 (the Chesapeake Bay Memo), James A. Hanlon, the director of the EPA's Office of Wastewater Management (U.S. EPA, 2004), stated that, for the protection of Chesapeake Bay and its tidal tributaries from excess nutrient loading, it was impracticable to express permit effluent limitations for nutrients (total nitrogen and total phosphorus) as daily maximum, weekly average, or monthly average effluent limitations.

The Chesapeake Bay Memo states that:

"Establishing appropriate permit limits (for nitrogen and TP) for Chesapeake Bay and its tidal tributaries is different from setting limits for other parameters such as toxic pollutants because: the exposure period of concern for nutrients loading to Chesapeake Bay and its tidal tributaries is very long; the area of concern is far-field (as opposed to the immediate vicinity of the discharge); and the average pollutant load rather than the maximum pollutant load is of concern"

The Chesapeake Bay Memo further states that:

"The nutrient dynamics of (Chesapeake) Bay may not be unique. The establishment of an annual limit with a similar finding of 'impracticability' pursuant to 40 CFR 122.45(d) may be appropriate for the implementation of nutrient criteria in other watersheds when: attainment of the criteria is dependent on long-term average loadings rather than short-term maximum loadings; the circumstances match those outlined in this memo for Chesapeake Bay and its tidal tributaries; annual limits are technically supportable with robust data and modeling as they are in the Chesapeake Bay context; and appropriate safeguards to protect all other applicable water quality standards are employed"

For the Spokane River, it was determined that it is impracticable to calculate appropriate average monthly and average weekly limits for TP, ammonia, and CBOD. Future variability of key TMDL constituents TP, ammonia, and CBOD are likely to be highly variable at the low concentration levels targeted in the TMDL. This makes it difficult to calculate appropriate monthly average and weekly limits with any degree of certainty and may result in artificially stringent limits which are unnecessary for protection of water quality. Further, water quality modeling of the Spokane River demonstrated that Lake Spokane is insensitive to short-term increases in loading of oxygen-demanding pollutants from point source discharges. The effluent limits for TP, ammonia, and CBOD for the Spokane River are based on far-field, as opposed to near-field, water quality concerns. Seasonal average mass loadings result in water quality protection equivalent to the TMDL.

6.5.4.2 Modeling of Equivalent Effluent Constituents

A water quality model may be used to demonstrate equivalency between parameters such as CBOD, TP, and NH3N when evaluating for dissolved oxygen. The model may be used to inform permitting and allow for alternative yet corresponding loads that result in equivalent dissolved oxygen impacts. In the Spokane River example, the wasteload allocations for ammonia (NH3-N), TP, and CBOD were established for each discharger based on a CE-QUAL-W2 model scenario from the TMDL. However, the modeling showed that the predicted dissolved oxygen water quality impacts in Lake Spokane vary from parameter to parameter. Equal mass discharges of each parameter from the same discharge location in the Spokane River watershed produce different predicted dissolved oxygen impacts.

For example, for identical discharge rates of phosphorus and ammonia from the same location into the watershed, the phosphorous discharge has been shown to have, through modeling, a larger impact on dissolved oxygen water quality in Lake Spokane than the ammonia discharge. Using the model results, the permitted point source's discharge limitations for phosphorous, ammonia, and carbonaceous biochemical oxygen demand can be converted to an "equivalent phosphorous" discharge limitation through the application of the exchange rates established for the permitted point source.

The Spokane River dischargers used the water quality model to demonstrate alternative yet equivalent discharge loadings. Each point source's permitted discharge limitations were set based on the WLAs established in the TMDL and the CE-QUAL-W2 model that has been used for the TMDL related modeling efforts. This model is the appropriate mechanism for determining the exchange rates between parameters and is available for use in scenario analysis. Additional modeling was completed by the Spokane River dischargers to present alternate loading scenarios that were equivalent to the scenarios in the TMDL in order to facilitate compliance with the restrictive TMDL (LimnoTech, 2010). This approach was supported by Washington Department of Ecology and EPA Region 10. The dischargers conducted a water quality modeling using the CE-QUAL-W2 model to examine the effect of alternative effluent limits on dissolved oxygen concentrations. The TMDL wasteload allocation assumed very low concentrations of effluent ammonia nitrogen in the month of March, which created a concern since it may be difficult to achieve nitrification with cooler wastewater temperatures in the spring. For these reasons, the alternate modeling scenarios examined higher March effluent ammonia concentration limits with revisions in total phosphorus and CBOD loadings to result in equivalent dissolved oxygen conditions to the TMDL wasteload allocation.

Alternate scenarios were modeled to evaluate allocations that provide the same or better receiving water benefit and to quantify the sensitivity of DO concentrations to changes in effluent concentrations and seasons. Initial modeling focused on decreasing the CBOD concentration and increasing the ammonia concentration in March. The results indicated that the reservoir DO concentration would not decrease, and would actually see a slight increase. Subsequent modeling scenarios included increased phosphorus concentrations (0.05 mg/l compared to 0.042 mg/l and 0.036 mg/l in the TMDL) with an elongated phosphorus reduction season.

The results of this modeling revised the structure of the Spokane River NPDES discharge permits by showing that the alternate scenarios would have the same water quality benefit as the TMDL. The resultant effluent limits were more manageable for wastewater treatment operations and reliability while achieving the same water quality benefit.

6.5.4.3 Spokane County Phosphorus, Ammonia, and CBOD Limits

Table 6-6 summarizes the effluent discharge permit limits for Spokane County for CBOD, ammonia nitrogen, and TP. The structure of this permit is unique in that the TMDL wasteload allocation has been interpreted to result in seasonal mass loading limits for the key TMDL parameters. Compliance with the effluent limitations for CBOD, ammonia nitrogen, and TP is based on the running seasonal average that is reported monthly. Monitoring for these parameters is required daily.

Table 6-7. Example of Final Permit Nutrient Limits, Spokane County.
Washington DOE, 2011b.

Effluent Limits: Outfall #001		
Parameter	**Seasonal Limit Applies March 1 to October 31 See notes f and g**	
Cabonaceous Biochemical Oxygen Demand (5-day)(CBOD5)	280 pounds/day (lbs/day)	
Total Phosphorus (as P) March 1 to Oct. 31	2.80 lbs/day	
Total Ammonia (as NH3-N)	**Seasonal Limit**	**Maximum Daily Limit**
For “season” of March 1 to March 31	1067.5 lbs/day average	16 mg/l
For “season” of April 1 to May 31	66.7 lbs/day average	16 mg/l
For “season” of June 1 to Sept. 30	16.7 lbs/day average	8.0 mg/l
For “season” of Oct. 1 to Oct. 31	66.7 lbs/day average	16 mg/l
Parameter	**Average Monthly**	**Average Weekly**
Carbonaceous Biochemical Oxygen Demand (5-day) (CBOD5), November 1 through February 29	2.0 milligrams/liter (mg/l) 133 pounds/day (lbs/day)	—
Select Footnotes		
f	Compliance with the effluent limitations for CBOD5, NH3-N and TP will be based on: 1) a seasonal average with the running seasonal average for the season reported monthly for tracking compliance with the allowable mass limitation, and 2) a combination of reported effluent quality, pollutant equivalencies in term of oxygen depletion and pollutant credits earned from Septic Tank Eliminations and approved by Washington DOE, following a revised run of the current, 2011, CE-QUAL-W2 model demonstrating compliance with DO TMDL wasteload allocation and permit conditions. The model run results and accompanying documentation will be submitted to the DO TMDL advisory committee for review and to Washington DOE for review, comment (if needed) and Washington DOE approval.	
g	Future adjustments to the final effluent limitations based on demonstrated pollutant equivalencies or non-bioavailable P will be implemented as major permit modifications requiring public notice and comment.	

6.5.5 Murderkill River Watershed TMDLs

The Murderkill River watershed is situated in Delaware and includes several tributaries and a large tidally influenced reach. A graphic of the watershed is shown in Figure 6-3. Waters in the tidal portions of the Murderkill River have been determined to not support designated uses because of low dissolved oxygen levels that are below the state water quality standards of 5 mg/l as a daily average and 4 mg/l as an instantaneous minimum. This led to significant monitoring and modeling efforts related to determining a TMDL.

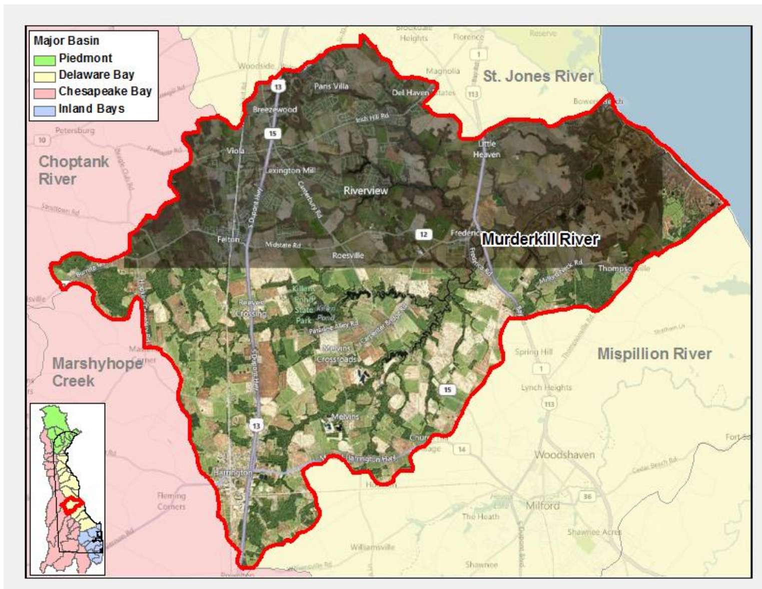

Figure 6-1. Murderkill River Vicinity Map and Watershed.
DNREC, 2014.

http://www.delawarewatersheds.org/wp-content/files/MurderkillRiver_lrg.png

The original Murderkill River Watershed TMDL was developed in 2001, with an amendment in 2005, and a proposed revision in 2014. The proposed revisions include alternative DO criteria and nutrient targets. These proposed alternative DO criteria and nutrient targets were based on two very important findings from the studies and modeling exhibited by response variables. These were that turbidity from the bottom due to tidal energy and exchanges of water with tidal marshes and wetlands had the most significant influence on DO.

Although changes in nutrient concentrations have little impact on DO levels, the influence of nutrients on the freshwater portion of the watershed is still significant. Model scenarios were used to develop annual average nitrogen and phosphorus loads. Changes to various sources were tested to estimate the impact on DO. The simulation of the response variable informed the revisions to the TMDL. The modeling resulted in permit limits for nitrogen and phosphorus structured as 12-month moving average mass loadings, as shown in Table 6-8.

Table 6-8. Kent County Effluent Discharge Permit Limits for Nitrogen and Phosphorus for Discharge to the Gut, a Tributary of the Murderkill River

DEQ, 2006.

Parameter	Effluent Limitations					
	Load			Concentration		
	Daily Average	Daily Maximum	Units	Daily Average	Daily Maximum	Units
Total Nitrogen	Moving12-Month Cumulative Average Load of 274,115 pounds					
TN May - Sept	751	1,126	lbs/day			mg/l
TN Oct – Apr			lbs/day			mg/l
Total Phosphorus	Moving 12-Month Cumulative Average Load of 22,812 pounds					
TP May - Sept	62.5	93.7	lbs/day			mg/l
TP Oct – Apr			lbs/day			mg/l

The effluent limitations for nitrogen and phosphorus are based on a moving 12-month cumulative average load computed by adding daily average discharge loads for the most current 12-months of operation. Monitoring is required once weekly with composite samples and the average of the results of the weekly composites for each month are reported as the daily average. This daily average is used to compute the 12-month cumulative average load. This daily average is multiplied by the number of days in the month to yield the cumulative load for the month. This load for the month is added to the calculated load for the previous 11 months and reported as the 12-month cumulative average load.

6.6 Simulation of Response Variables to Inform Permitting

A number of states are structuring nutrient criteria with greater emphasis on response variables (DO, pH, algae, etc.) rather than relying exclusively on nitrogen and phosphorus concentration values as the sole basis for impairment determinations. The ability of water quality models to simulate response variables allows effluent discharge permit limit scenarios to be evaluated to demonstrate the site-specific response to nutrient loadings.

The use of a predictive model can be fairly simplistic, as seen in the traditional approach and application of water quality models. In the most rudimentary form, the model can be an equation that combines the upstream flow and concentration with the discharge flow and concentration to estimate receiving water conditions. The equation can be repeated multiple times to develop a spreadsheet model of a river network. Such a mass balance model of nutrients can then be tested with alternative inputs from the sources to examine if targets are met. The model can be further expanded to include cause and affect variables that are simulated in more complex dynamic water quality models. Again different combinations of reductions in source inputs can be tested and compared to in-stream targets for nutrients and response variables, such as DO, pH, etc. Examples of this approach were described earlier for the Clark Fork and Spokane River.

Water quality models can also be used to simulate the biological indicators. “The most commonly used nutrient-related response indicators by states include dissolved oxygen, pH, water clarity, algal biomass/type, and various other biological indicators” (Bierman et al., 2013). Predictive water quality models available today generally include about 30 state variables to represent chemical or biological parameters commonly measured in waterbodies. These models have many commonalities in state variables and underlying algorithms, and are usually able to use these in combinations that represent the processes that occur within the receiving waters.

6.6.1 Site-Specific Criteria and Permit Conditions

The federal water quality standards regulation at section 13 1.1 l(b)(l)(ii) provides states with the opportunity to adopt water quality criteria that are "…modified to reflect site-specific conditions." A site-specific criterion is intended to reflect conditions necessary for aquatic life at the site, usually by taking into account the biological and/or chemical conditions. The development and use of site-specific criteria must be based on a sound scientific rationale in order to protect the designated use. Once adopted, site-specific criteria may then be used in the development of permit conditions.

The following sections describe states where the foundation to utilize water quality models to simulate response variables in conjunction with nutrient criteria is being established. This may result in more applications of water quality models to inform the structure and limits for nutrients in discharge permits.

6.6.2 Montana Nutrient Variances and Yellowstone River

In July 2014, the Montana Department of Environmental Quality published guidance on nutrient variances (Montana DEQ, 2014d) in conjunction with the state rulemaking process on numeric nutrient criteria. Montana DEQ Circular DEQ-12A contains the base numeric nutrient standards’ concentration limits and designates the waterbodies and locations where the standards apply, their period of application, etc. Circular DEQ-12B provides the guidance for circumstances where the base numeric nutrient standards cannot be achieved because of economic impacts, the limits of technology, or both. Circular DEQ-12B allows for variances from the base numeric nutrient standards in Circular DEQ-12A.

In addition to a general nutrient variance that is available statewide, Circular DEQ-12B provides for individual nutrient standards variances as an alternate method for deriving appropriate interim effluent limits for an individual discharger. These individual variance effluent limits are based on site-specific monitoring and/or water quality modeling. “In some cases a permittee may be able to demonstrate, using water quality modeling and reach-specific data, that greater emphasis on reducing one nutrient (target nutrient) will achieve the highest attainable condition, since it would produce comparable water quality and biological conditions in the receiving water as could be achieved by emphasizing the equal reduction of both nutrients (i.e., both nitrogen and phosphorus)” (Montana DEQ, 2014d). Selection of the water quality modeling approach is left to the proponent. The permittee will be required to submit the information for review and approval by Montana DEQ. Predictive models may be one approach selected to provide this demonstration.

On the Yellowstone River, the Montana Department of Environmental Quality used a computer water quality model to derive numeric nutrient criteria (Montana DEQ, 2011b). A Yellowstone River model was developed using steady state QUAL2K model (one-dimensional upstream to downstream), coupled with an AT2K benthic algae model for cross sections (one-dimensional from bank to bank. These are mechanistic models that include the prediction of in-stream nutrients, dissolved oxygen, and benthic algae.

These models were used to investigate the predicted benthic algae density response to various combinations of nitrogen and phosphorus wastewater treatment levels. This evaluation is similar to that required by Circular DEQ-12B. The two point source discharges were simulated at a variety of effluent nutrient concentrations based on the representations of a progressive level of advanced nutrient removal treatment used in a WERF nutrient sustainability study (WERF, 2011). Model simulations included maintaining the same ratios of organic N, ammonia N, and nitrate+nitrite N to total nitrogen and organic P and inorganic P to total phosphorus that were characteristics of the treatment levels used in WERF sustainability study (WERF, 2011). The models were further modified to represent the reach of the Yellowstone River where the largest utility in the watershed, the City of Billings, discharges.

Figure 6-2 illustrates the benthic algae response to reductions in both nitrogen and phosphorus at two downstream locations on the river. An interesting result of the simulated benthic algae response to reductions in nutrient loadings is that the model indicated that the most pronounced reductions in algae densities are in response to phosphorus, but less so in response to nitrogen. Figure 6-3 illustrates the simulated benthic algae in response to reductions in effluent phosphorus alone, from 2.5 mg/l to 0.05 mg/l. Benthic algae dropped from 120 to approximately 40 mg Chl-a/m2 and the pattern of reduction was similar to the predicted pattern of reduction resulting from control of both nitrogen and phosphorus. Figure 6-4 illustrates the simulated benthic algae in response to reductions in effluent nitrogen alone, from 15 mg/l to 2 mg/l. The simulated benthic algae density is not reduced to the same extent as the reductions in phosphorus generated.

This suggests that both nitrogen and phosphorus do not need to be reduced to equally low levels to achieve water quality benefits in terms of benthic algae. For the conditions simulated, the most significant reductions in benthic algae occur when reducing effluent phosphorus concentrations from secondary effluent levels to Level 3 (0.20 mg/l). Further reductions in effluent phosphorus provide diminishing benefits in terms of further benthic algae reduction.

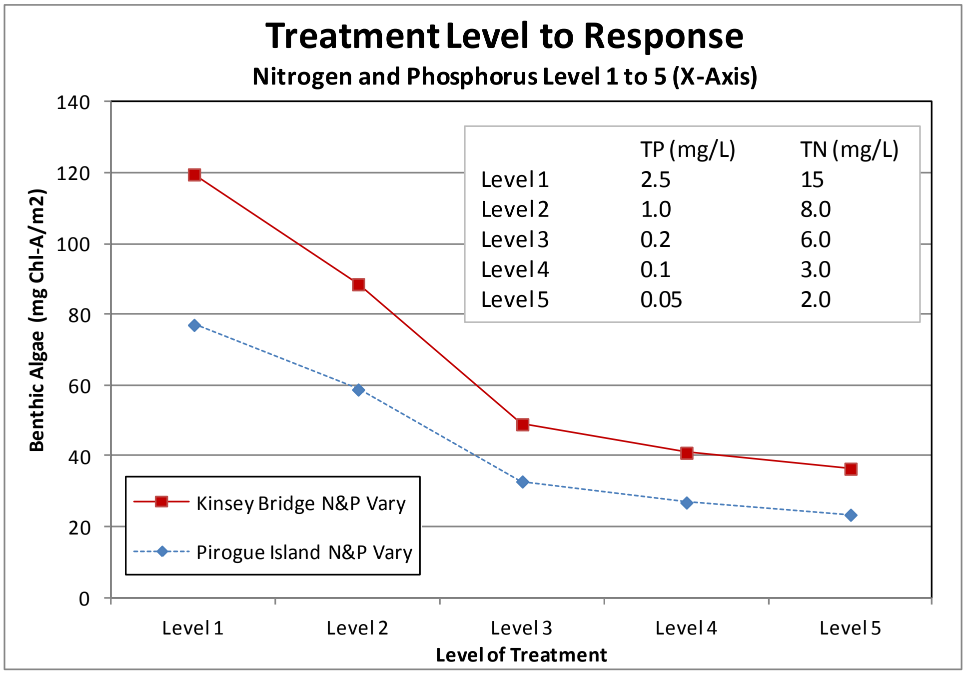

Figure 6-2. Simulated Yellowstone River Benthic Algae Response to Reductions in Both Nitrogen and Phosphorus Loadings.

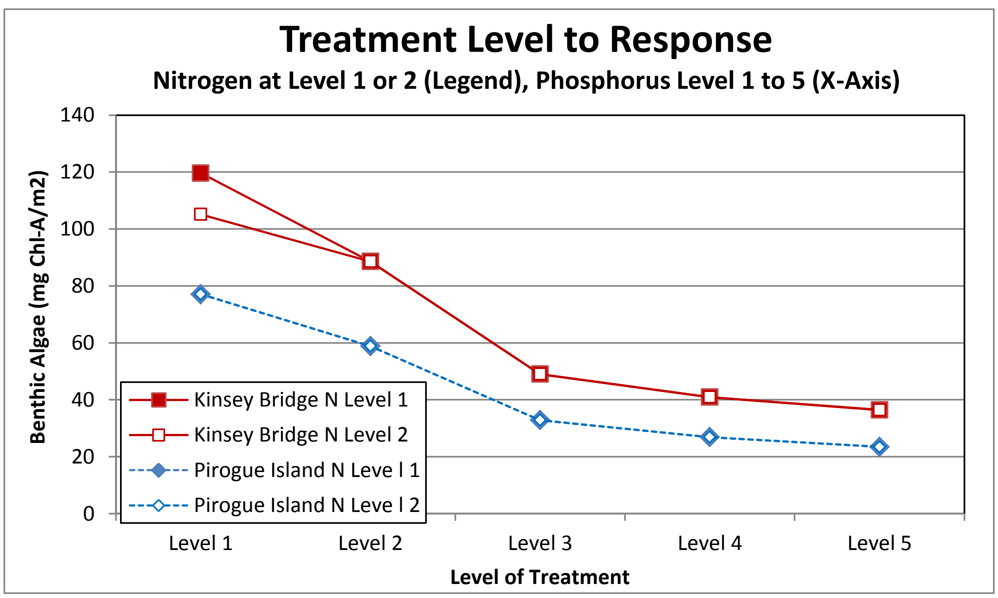

Figure 6-3. Simulated Yellowstone River Benthic Algae Response to Reductions in Phosphorus Loadings.

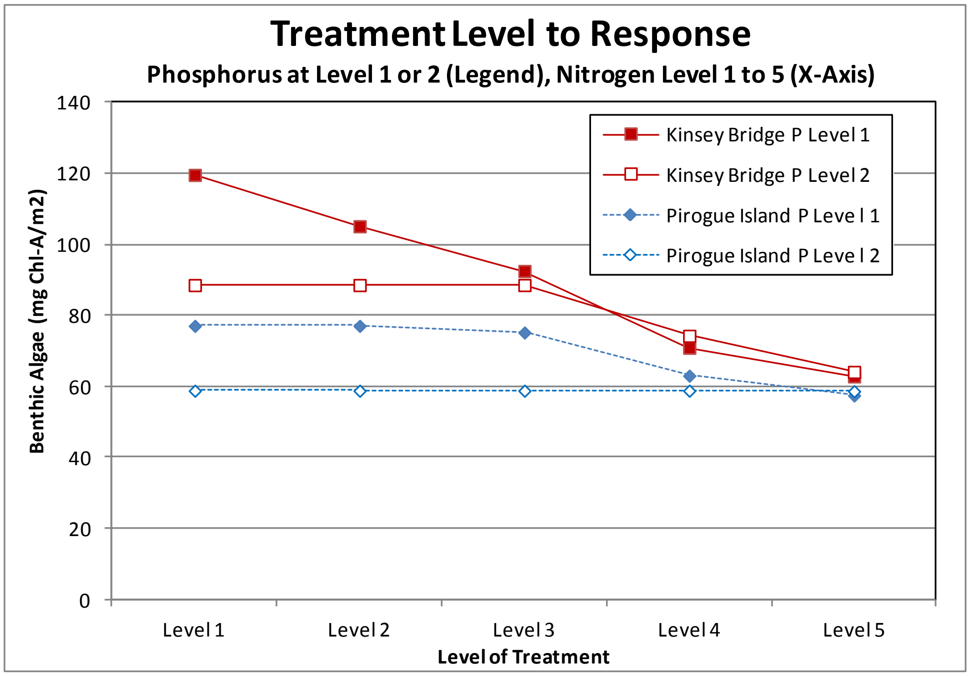

Figure 6-4. Simulated Yellowstone River Benthic Algae Response to Reductions in Nitrogen Loadings.

6.6.3 Florida Standards Example

Within the Florida DEP surface water quality standards (Chapter 620302) is information about specific numeric interpretations of the narrative nutrient criterion. Related to the concepts of using water quality models to simulate response variables, this information indicates that if nutrient concentrations exceed threshold levels while water quality is still meeting standards as demonstrated by the biological indicators, then the nutrient concentrations within the waterbody are acceptable. This approach provides a degree of flexibility in considering nutrients in context with overall waterbody quality conditions.

The perspective was similarly recommended by the EPA Science Advisory Board and used by EPA in its 2012 proposal of numeric nutrient criteria for Florida waters. Nutrient impacts are highly site-specific and DEP developed estuary-specific nutrient criteria rather than generic criteria that apply to all waters. For estuarine waters the response variables to determine water quality conditions to consider included more general or narrative conditions, along with more specific numeric conditions. The general considerations include an evaluation of historical or recent seagrass coverage and Secchi depth measurements. The specific considerations include the following:

- Site-specific seagrass depth and water clarity targets to achieve 20% of surface light at the mean depth of the deep edge of seagrass beds.
- A chlorophyll-a target to prevent nuisance algal blooms such as chlorophyll a not to exceed 20 µg/l greater than 10% of the time based on annual data.
- Dissolved oxygen targets to protect aquatic life such as minimum allowable daily dissolved oxygen saturation of 42%, at least 90% of the time, based on annual data.

These standards are examples of where the focus is on the response variables. Predictive models may be used to evaluate nutrient concentrations that achieve response variables such as aquatic growth levels, chlorophyll a, and dissolved oxygen. In this way, nutrient control efforts are intended to focus on overall waterbody health and quality, not solely on nutrient concentrations.

6.6.4 Ohio's Trophic Index

In Ohio, the viewpoint is that there is a continuum of enrichment from nutrients and this continuum cannot be directly interpreted (Ohio EPA, 2013). There are numerous confounding factors that result in the difficulty of predicting the response to nutrients. An approach proposed in Ohio is to examine how biological condition changes occur over a nutrient gradient. The result has been to identify benchmarks or thresholds relating observed conditions to the water quality. "The Trophic Index Criterion (TIC) is a composite index that brings together the measures of nutrients, periphyton, dissolved oxygen, and biological assemblages by awarding points to successive ranges of each indicator, where the ranges are defined by benchmarks identified in the nutrient study" (Ohio EPA, 2013). Using various measures, the TIC provides an indication of whether water quality is acceptable, threatened, or impaired.

"Unlike toxicants and putrescible materials, the effects of nutrient pollution on fish or macroinvertebrates are indirect, and therefore not predictable through simple dose-response curves, or highly deterministic models" (Ohio EPA, 2013). This is a different approach to examining the response variables that can still be applied to nutrient management programs such as NPDES permits and TMDLs. The TIC can still be used with modified inputs to simulate the predicted response using water quality models. "TIC scores downstream from a new or expanding discharger would be projected using modeling techniques" (Ohio EPA, 2011). For example, "if the modeled TIC score is in the impaired or threatened category, reasonable potential would exist, and limits based on the WLA would be included in the NPDES permit" (Ohio EPA, 2011). A predictive water quality model(s) may need to be used with the TIC to perform such an assessment.

6.6.5 Maine's Decision Framework

A decision framework was developed in Maine to first determine if there is impairment of a beneficial use and then determine if phosphorus or another nutrient caused or contributed to the impairment. This framework provides a means to address many environmental response criteria to cover a variety of waterbody types, such as lakes, impoundments, small rocky streams, slow streams, and large rivers. "For Maine Pollutant Discharge Elimination System (MEPDES) permits, or NPDES permits for interstate waters, where total phosphorus limits are warranted, the values (within the framework) will be used to determine appropriate total phosphorus limits, unless replaced by a site-specific value" (Maine DEP, 2012). Water quality models may be used in a variety of situations including, where one already exists or is developed where a facility discharges, where multiple facilities discharge to assure assimilative capacity, and for site-specific considerations (Maine DEP, 2014). Modeling can be used to address the variability of phosphorus impacts on receiving waters.

6.7 Extended Period Simulations

A powerful component of using predictive models is using unsteady (time variable conditions) water quality models that simulate conditions over a period of time. The period may be a month, season, or year, and it can also be multiple months, seasons, or years. Extended period simulations with water quality models can provide a greater understanding of conditions than examining a single point in time, or a single critical condition. Instead of analyzing a single condition, an extended period simulation generates a time series of results, such as the water quality response variable, which then can be examined in multiple ways. Examples of how the results may be examined include as a time series in comparison to target values or criteria, along with basic statistics, or as a frequency distribution. The water quality model may be constructed to represent existing conditions, calibrated based on monitoring data, and then used in a predictive mode to examine potential future scenarios.

A long-term estimate of future conditions, rather than a single data point in time, can provide much greater insight into the formulation of discharge permits and the probability of the impact of the discharge on receiving water quality. While there is benefit to the additional information gained in an extended period simulation, the model must also be representative based on a calibration over a longer period. This requires time and effort to construct and simulate, and results in larger datasets to post-process. However, with the computing power and data storage capabilities available today, these should be few barriers to further application of extended period simulations. Further, statistical software is available to aid in post-processing of large datasets to produce meaningful information to inform the permitting process.

Predictive models can provide results over a period of time to allow the frequency of water quality conditions over this period to be examined for potential exceedances. The results of predictive models are often compared to a standard, and the magnitude of exceedance computed. An extended simulation over time period allows the magnitude of the exceedance be examined in terms of how often and for how long that magnitude potentially exceeds a target. Discharge permitting also incorporates the concepts of magnitude, duration, and frequency by the way that permits are structured with daily, weekly, monthly, and/or seasonal limitations. Predictive models that provide information about the frequency of water quality conditions can help inform the structure of the permit limitations.

6.7.1 Spokane River Effluent Variability and Water Quality Modeling

For the Spokane River TMDL and permitting effort described earlier in this chapter, the CE-QUAL-W2 model of the Spokane River was used to test two effluent variability scenarios. The scenarios were set up to examine whether downstream dissolved oxygen concentration impacts would be different for constant versus variable total phosphorus discharges. The purpose was to determine whether or not it was important to constrain effluent limits over a short time period, or whether longer seasonal average effluent limitations would provide adequate water quality protection. The scenarios were: 1) a constant total phosphorus concentration from the dischargers; and 2) an equivalent annual loading but daily varying effluent total phosphorus concentration from the wastewater dischargers. For the seven wastewater dischargers to the Spokane River, the future loading scenarios that were simulated in the CE-QUAL-W2 model were as follows:

- Base model with dischargers effluent total phosphorus set to constant 50 ug/l.
- Base model with dischargers effluent total phosphorus set with daily variable concentration pattern based on a data set with a Coefficient of Variation of 1.2.

Three model inputs were modified to simulate future conditions based on upgrades to the wastewater facilities for advanced phosphorus removal. The TP was partitioned between orthophosphorus as P and biological oxygen demand as P in the model input. Additionally, BOD was modified. For BOD, if the base model value was greater than 15 mg/l it was reduced to 15 mg/l assuming an enhanced future treatment process when operating for nutrient removal, and if it was less than 15 mg/l the base model value was used.

For the 50 ug/l simulation the orthophosphorus as P was set at 0.017 mg/l and the BOD as P at 0.033 mg/l (for a total TP of 0.05 mg/l) for all seven dischargers. The orthophosphorus as P value was set based on a PO4/TP ratio of 34% based on the expected performance of future advanced treatment process for low effluent phosphorus, ammonia, and CBOD.

For the Coefficient of Variation simulation, the total phosphorus concentration was based on performance data from existing treatment plants designed and operated for low effluent phosphorus. The total phosphorus mean of this dataset is approximately 0.1 mg/l. The values were scaled to reduce the magnitude of the mean target level of 0.05 mg/l for the Spokane River simulation. Each discharger was assumed to have a similar degree of variability in effluent concentration, but each was also assumed to have unique periods of variations so that peaks did not coincide. All have the same mean of effluent phosphorus of 0.05 mg/l and coefficient of variation of 1.2. The total effluent phosphorus variation for the seven dischargers is shown in Figure 6-5. The total phosphorus concentration was than partitioned between orthophosphorus as P and biological oxygen demand as P using the same 34% ratio for all effluent.

The model simulation results for the two scenarios were post-processed using the approach developed in the Spokane River TMDL. The post-processing is by model segment number in the downstream reservoir and does not aggregate the dissolved oxygen into a single reservoir representative value. The difference between the two simulations (constant v. variable effluent phosphorus concentration) shows a maximum deviation in the depression in DO of 0.06 mg/l in any of the reservoir model segments and an average increase of 0.01 mg/l. The maximum difference occurs near the headwaters of the downstream reservoir, but it occurred during a period where there were no spikes in the discharger total phosphorus concentrations.

Simulation of variable daily effluent phosphorus concentrations, including maximum variations as high as 0.450 mg/l, results in similar dissolved oxygen conditions in the river and reservoir to the constant effluent concentration, as predicted by the model. This analysis demonstrated that tighter effluent concentration limits, or capping effluent concentrations at a constant 0.05 mg/l level that cannot be exceeded, provides no additional water quality benefit in terms of dissolved oxygen. Further, variation in the effluent total phosphorus concentration is a more realistic representation of achievable advanced wastewater treatment performance for low effluent phosphorus. Including an allowable variation in the discharged total phosphorus is beneficial for practicable treatment facility operation while maintaining equivalent protection of river water quality. This sensitivity analysis demonstrates that it is unnecessary to limit maximum daily effluent phosphorus concentrations and that seasonal average limits provide equivalent water quality protection. The results have direct implications for the determination of effluent discharge permit limits. Water quality models can incorporate variable effluent concentrations, instead of using a single value, and demonstrate the results on receiving water quality, as well as provide insights into the appropriate structure of discharge permits, such as the seasonal effluent limitations in this example.

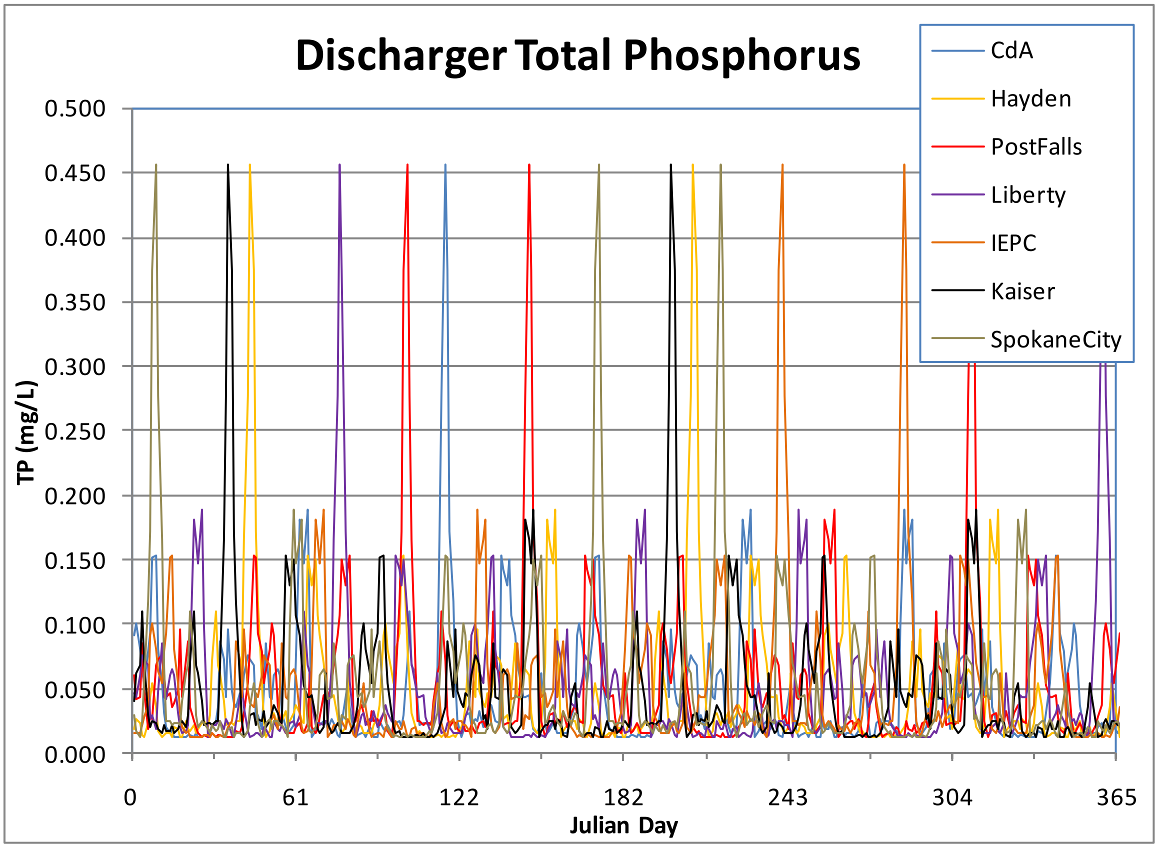

Figure 6-5. Variable Effluent Phosphorus Concentration Pattern Used in Spokane River CE-QUAL-W2 Simulations of Dissolved Oxygen for Comparison with the Constant 0.050 mg/l Effluent Concentration Scenario.

6.7.2 Lower Boise River Modeling

The Lower Boise River has impaired beneficial uses listed as cold water aquatic life, contact recreation, and salmonid spawning due to phosphorus (DEQ, 2015). An AQUATOX model of the river was developed to support a phosphorus TMDL and to examine the response of benthic algae (periphyton) to river conditions and phosphorus loadings. A periphyton target of 150 mg/m^2 has been selected for the Boise River and the downstream Snake River TMDL calls for a reduction in phosphorous loading from the Boise River to less than 70 µg/l.

The Lower Boise River is a highly managed river with flow that is controlled by upstream reservoirs, along with numerous irrigation diversions and return flows from agriculture. Land uses in the watershed illustrated in Figure 6-6 are primarily agriculture and urban/suburban development. The complexity of the river system created challenges in constructing the water quality model, interpreting results, and understanding the critical factors driving periphyton density, the response variable. The water quality model provides a tool to examine different ways that the phosphorus loading model inputs and results can be viewed to understand the critical factors affecting the response variable (benthic algae) and to analyze scenarios to inform permitting.

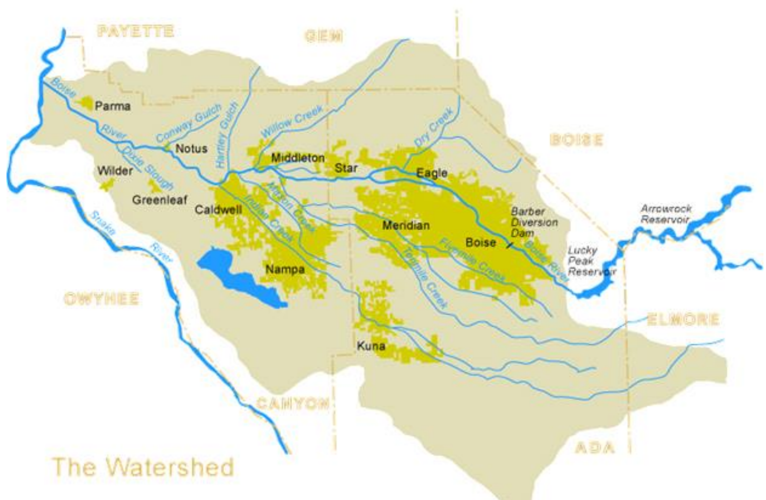

Figure 6-6. Lower Boise River Vicinity Map and Watershed.
LBWC, 2014.
http://www.lowerboisewatershedcouncil.org/images/WhoWeAre_Map.jpg

Periphyton density predicted by the model can be examined in a variety of ways. The results can be viewed at one point in time and at a single location, or more broadly over multiple river segments and longer periods of time. Analyzing model predicted periphyton density as a maximum benthic algae target at any single location and point in time may be an overly conservative approach since it suggests that the target level can never be exceeded. This may be unnecessary to protect beneficial uses and result in suggesting unattainable levels of nutrient source controls. Thoughtful consideration must be given to the selection and intent of the target criterion so that model results can be interpreted appropriately. Aquatic life and recreational uses would generally not be thought to be impaired if a single rock, pool or riffle, or even a short reach of river had benthic algae higher than a target value. Further, the ability of the water quality model to generate numerical results for benthic algae density at every location and at every point in time may be misleading in that it suggests a greater level of precision than perhaps warranted, especially considering the high degree of variability found in field sampling techniques to actually measure periphyton density. It may be more appropriate to average model results over a river segment, or segments, and over a period of time, such as the summer growing season. This may allow for greater flexibility in interpreting the modeling results in comparison to the response variable criteria.

For the lower Boise River, a 26-year continuous flow record is available to support an extended period simulation and conduct a statistical analysis of the benthic algae density results. The daily model results for periphyton from the 26-year simulation period were statistically analyzed and provide insights not possible otherwise from the single year TMDL simulation. Figure 6-7 presents a comparison of the single year TMDL model results for the critical river segment for the month of September 2012. For comparison, the 26-year simulation of benthic algae is also shown. The TMDL model exceeds the 150 mg/m2 periphyton target for nearly the entire month. However, the 26-year extended period simulation shows that the periphyton target will be met on average.

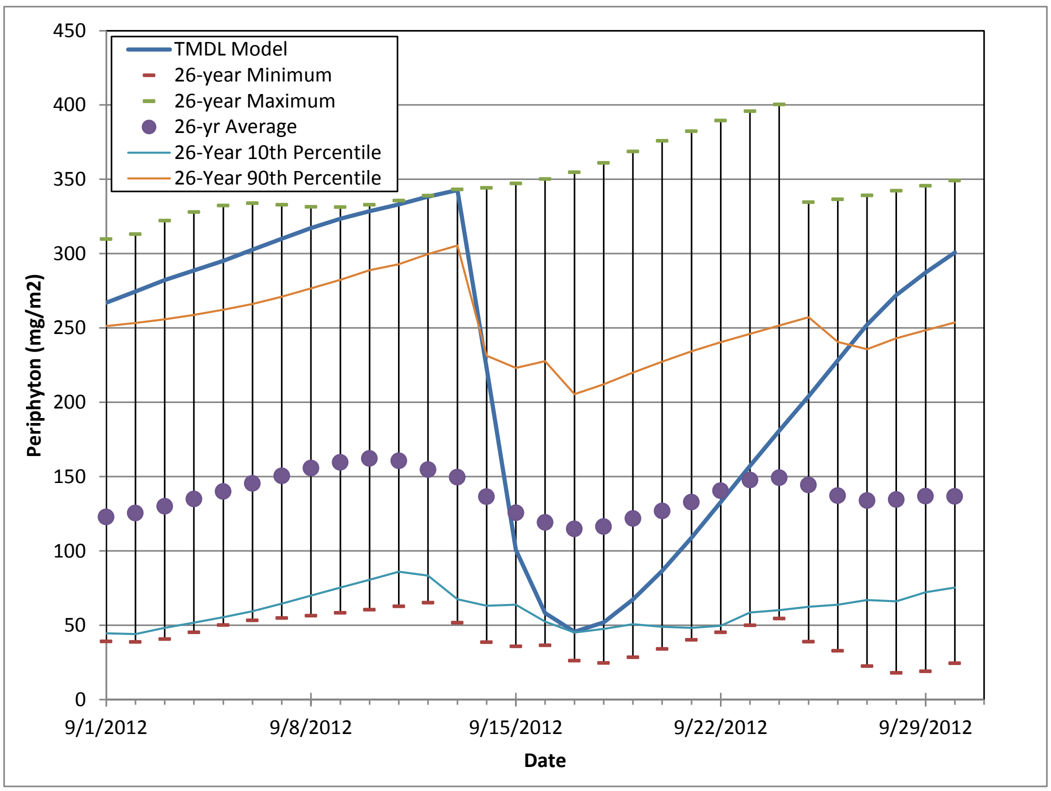

Figure 6-7. AQUATOX Model Results for Lower Boise River Comparing TMDL Model Period and 26-year Period Simulations.

The statistical summary in Table 6-9 provides a side-by-side comparison of the single year TMDL model and the 26-year simulations of benthic algae. The TMDL model predicted periphyton was greater than the 150 mg/m2 target. However, the 26-year period simulation shows that on average, the periphyton target will be met. At the 90th, 95th, and 99th percentiles, neither the TMDL model, nor the 26-year period model will satisfy the periphyton criteria. In fact, at the low in-stream target levels for phosphorous of less than 70 μg/l, the model shows little response in terms of periphyton density. On the other hand, stream flow and river conditions have a more pronounced effect on periphyton.

Table 6-9. Comparison of Boise River Periphyton Statistics for TMDL Period and 26-Year Period Simulations.

Statistics	TMDL Model Period September Periphyton (mg/m^2)	26-year Period Simulation September Periphyton (mg/m^2)
Median	270	116
Average	225	138
90th Percentile	329	263
95th Percentile	336	319
99th Percentile	342	351

The extended period simulation indicates that management of the Boise River is more influential than control of phosphorus loadings. Despite that, effluent discharge permits have been prepared with the in-stream phosphorus target of 70 μg/l as a monthly effluent limit. Weekly limits and mass limits are also imposed, as show in an example permit in Table 6-10.

Table 6-10. Example Boise River Phosphorus Limits from City of Meridian Draft NPDES Permit.
U.S. EPA, 2014.

Effluent Limitations and Monitoring Required for Boise River Outfall				
		Effluent Limitations		
Parameter	Units	Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit
Total Phosphorus (May – September)	μg/L	70	165	–
	lb/day	5.95	14.0	–
Total Phosphorus (October – April)	mg/L	Report	Report	–

6.7.3 Upper Mississippi River and Lake Pepin Water Quality Modeling

The MCES operates multiple wastewater treatment facilities in the greater Minneapolis area. The discharge from these facilities ultimately reaches Lake Pepin on the Mississippi River. The Minnesota Pollution Control Authority (MPCA) recommended standards for Lake Pepin are 100 μg/L total phosphorus and 28 μg/L chlorophyll-a (MPCA, 2010b). The intent is to protect aquatic recreation beneficial uses in Lake Pepin and in downstream pools in the watershed shown in Figure 6-8.

Figure 6-8. Lake Pepin Vicinity Map and Watershed.
MPCA, 2014.
http://www.pca.state.mn.us/artwork/maps/lakepepin-watershed.jpg

Phosphorus removal was implemented at the MCES Metro Plant between 1997 and 2003 to meet an effluent phosphorus limit of 1 mg/L that was imposed at the end of 2005. Table 6-11 illustrates the structure of the discharge permit with concentration and mass limits (431 MT/year) for phosphorus on a 12-month moving average basis. Progressive reductions in the annual mass of phosphorus have resulted in significant in-stream phosphorus reductions. Nevertheless, MPCA has proposed a further reduction in effluent phosphorus with a wasteload allocation of 200 MT/year (200,000 kg/yr) as the basis for initial water quality based effluent limits.

Table 6-11. Example of Final Effluent Limitations Based on Traditional Deterministic Approach.

Parameter	Limit	Units	Limit Type
Total Phosphorus	1.0	1.0 mg/L	12 Month Moving Average
Total Phosphorus	431,077	kg/yr	12 Month Moving Total

The proposed wasteload allocation from MPCA in 2010 included 200 MT/year for the MCES Metro Plant and a total of 37 MT/year for three of the other MCES facilities discharging to the Mississippi River (Eagle's Point, Hastings, and Empire). This would result in a phosphorus limit for the MCES Metro Plant equivalent to an effluent concentration of 0.46 mg/l at the plant design flow of 314 mgd. Following this initial wasteload allocation reduction, further reduction requirements could follow to attain the 100 μg/L total phosphorus and 28 μg/L chlorophyll-a targets.

A review of the water quality model found that the model tends to under-predict total phosphorus levels and over predict chlorophyll-a levels in Lake Pepin. This total phosphorus under-prediction may produce lower lake total phosphorus requirements than necessary and could be critical if lake total phosphorus levels (as opposed to chlorophyll-a levels) limit the allowable effluent load. The model bias in computing chlorophyll-a levels could result in unnecessarily low phosphorus effluent limits to comply with the summer chlorophyll-a target of 28 μg/L.

An assessment of the historical water quality data and modeling results showed a strong correlation between Lake Pepin summer (June through September) chl-a levels and river flow conditions. Low summer river flows correspond to high chlorophyll-a levels in Lake Pepin. Water quality modeling demonstrated that the Lake Pepin water quality response to further changes in the MCES Metro treatment plant phosphorus load is minimal.

Historical Lake Pepin summer phosphorus and chlorophyll-a concentrations were reviewed over an extended period from 1991 through 2009, as shown in Figure 6-9. A 10-year moving average period was proposed for determining the phosphorus load reductions necessary to comply with the chlorophyll-a criteria of 28 μg/L in Lake Pepin. The long-term average phosphorus level in Lake Pepin over this period averaged 171 μg/L and the corresponding chlorophyll-a averaged 25.5 μg/L, which is lower than the target of 28 μg/L. Therefore, the chlorophyll-a objective for Lake Pepin may be achieved at a higher phosphorus concentration than proposed by MPCA.

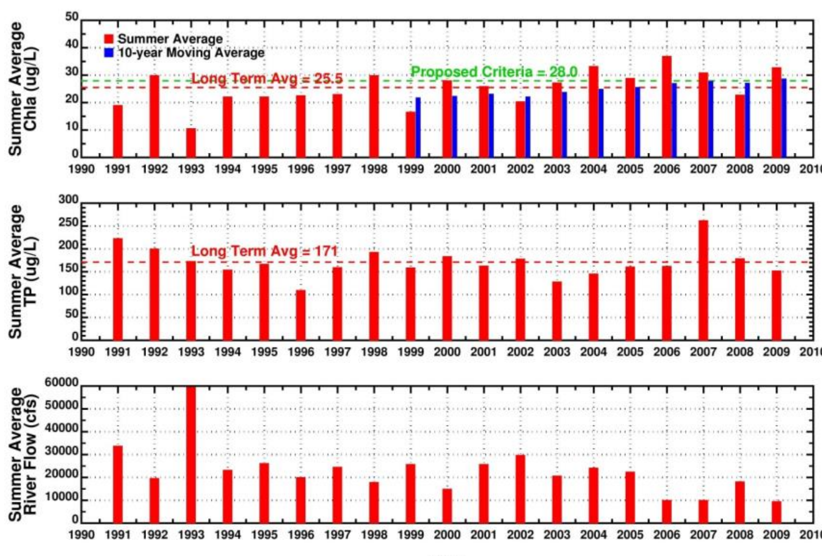

Figure 6-9. Lake Pepin Measured Summer Average Chlorophyll-a and Total Phosphorus.

CHAPTER 7.0

PROBABILISTIC PERMITTING

A probabilistic approach to nutrient discharge permitting allows the variability in flows and concentrations to be recognized and the most extreme flows and concentrations placed in proper perspective with more typical conditions. A probabilistic approach to nutrient discharge permitting is advantageous because it can utilize a distribution of values for key parameters in the development of effluent limits to portray the variability that exists in effluent and receiving water flows and constituent concentrations. Deterministic permitting approaches may be overly restrictive in limiting nutrient discharges because they combine conservative assumptions in each aspect of the development of effluent limits: wastewater flow, effluent nutrient concentration, receiving water flow, and ambient water nutrient concentration. It is unlikely that there will be a convergence of the most extreme values for flow and concentration, in both the effluent discharge and the receiving waters, at the same time. That is to say that there is little chance that the highest effluent concentration at maximum wastewater discharge will coincide with the highest receiving water concentration at the lowest receiving water flows.

This chapter explores the use of probabilistic methods in the development of nutrient effluent limits. The focus is on variability of effluent and receiving water flows and concentrations. Since there are a limited number of actual probabilistic based nutrient permits from which to examine case study histories, this chapter will use other examples to highlight this approach. Deterministic nutrient permitting is discussed in Chapter 3.0. Chapter 5.0 on technology performance statistics provides detailed statistical descriptions of effluent nutrient concentrations resulting from a number of advanced nutrient removal processes that can be used in conjunction with the probabilistic approach presented in this chapter. The use of fate and transport water quality models to inform the development of nutrient discharge permits is addressed in Chapter 6.0.

7.1 Probabilistic Permitting Approach

The probabilistic methodology allows for the variability of effluent and receiving water flows and nutrient concentrations to be represented by probability distributions. The potential for those variable data to coincide can then be quantified statistically and used to inform the development of discharge permits. In contrast, the traditional deterministic approach to developing effluent limitations uses specific effluent conditions (flow and concentration) in combination with specific upstream receiving water conditions (flow and concentration) to calculate the predicted downstream concentration. If the predicted downstream concentration exceeds the water quality standard or nutrient target, then effluent limitations are required. The approach taken to RPA typically combines the maximum effluent discharge and concentration with the highest observed ambient concentrations during a low receiving water flow condition (e.g., 7Q10, 14Q5, 30Q10, etc.). If reasonable potential to cause or contribute to the exceedance of a water quality standard is established, then effluent limits are back calculated from the in-stream target concentration using a similar mass balance approach, again with a selection of conservative values. Generally, the deterministic approach using the most conservative values results in the calculation of the worst possible mixed downstream condition. EPA noted in the TSD for Water Quality-based Toxics

Control (U.S. EPA, 1991) that these conditions would occur rarely, or never, and this approach would result in permit limits more stringent than necessary.

Examining a range of effluent and upstream flow and concentration conditions can provide a distribution of potential outcomes in terms of mixed downstream conditions and can predict the frequency of their occurrence. This probabilistic approach can represent the variability in actual conditions beyond the selection of a single specific value and provides a more realistic representation of receiving waters over a wide range of conditions. Probabilistic and predictive approaches may be used to develop these distributions. The result is a broader perspective of whether there is reasonable potential to impact water quality, along with more information about the potential magnitude, frequency, and duration of downstream water quality conditions. This information can be compared with the receiving water requirements that have been established by numeric nutrient criteria, water quality modeling, TMDL wasteload allocation, etc. as necessary to protect receiving water quality.

7.1.1 Probabilistic Development of Effluent Limits

Effluent limits developed in the traditional deterministic approach are back calculated directly from an acceptable downstream mixed concentration condition based on the applicable water quality standard or wasteload allocation. Probabilistic calculations result in a distribution of downstream conditions that can be compared to either an allowable frequency of exceedance of the applicable standard, or a probabilistic representation of an acceptable downstream condition as a probability distribution rather than a single value. Development of effluent limits using a probabilistic approach will require calculation of the downstream conditions, followed by a comparison with the allowable frequency of exceedance. This may be followed by successive iterations with refined effluent flow and nutrient concentration values to converge on the effluent limits necessary to satisfy the downstream conditions.

Monte Carlo analysis is a method for using the full probability distributions for each of the parameters in the mass balance approach to develop effluent limits. A Monte Carlo simulation may be used to combine the effluent and receiving water flow and concentration data and calculate the probability distribution for the downstream mixed conditions. The Monte Carlo analysis results in the probability distribution of calculated in-stream concentrations, which can then be evaluated in comparison to the in-stream target concentration.

The Monte Carlo analysis can test multiple combinations of parameter values based on statistical distributions. The statistical distributions for each of the four parameters (receiving water flow and concentration, effluent flow and concentration) are defined by the mean and standard deviation in log normal distributions. Minimum and maximum values are used to constrain the log normal distributions so that the tails are finite. Providing that an appropriate sample size of data are available, the mean and standard deviation for the parameters may be computed from the data time series and used in the Monte Carlo analysis to develop effluent limits. The data requirements for this approach to permitting are minimal in comparison to other modeling techniques, such as dynamic fate and transport water quality modeling. Permit writers usually have site-specific receiving water flow and ambient concentration data sets available to analyze for use in traditional deterministic permit calculations.

Monte Carlo analysis has been identified as an appropriate approach to the development of effluent limits to address variability, as will be discussed in greater detail in this chapter in the section on EPA's TSD for Water Quality-based Toxics Control (U.S. EPA, 1991). In the past, the lack of readily available computing power may have limited the application of Monte Carlo analysis in discharge permitting. However, easily accessible software packages, such as the @Risk extension for spreadsheet calculators, can quickly conduct Monte Carlo simulations in minutes or seconds with multiple iterations. The software is user friendly and does not require an extensive background in statistical methods. The probabilistic approach requires little additional effort to develop the entire range of outcomes for the resulting receiving water concentration conditions. The variability in environmental factors, river flows, and ambient concentrations, along with wastewater treatment plant performance, effluent flows, and concentrations, are included in the Monte Carlo simulation.

7.1.2 Compliance with Probabilistic Effluent Limits

Assessing compliance with probabilistic limits can introduce challenges, depending upon whether they are expressed in terms of effluent quality or receiving water quality, and depending upon whether or not adequate data are available with which to conduct an evaluation. Effluent limits expressed as a statistical value of effluent concentration, such as the 50th percentile of concentration (median), are readily assessed based on the effluent data collected for the required period in the NPDES permit (e.g., annual, monthly, weekly). Compliance with effluent limits based on probability statistics can be determined by statistical analysis of effluent monitoring data and is done quite commonly. Chapter 5.0 presents a discussion of TPS that characterize the variability in effluent performance associated with nutrient removal treatment facilities in statistical terms. In some nutrient discharge permits there are inconsistencies in the structure of the effluent limits and the specified monitoring frequency for effluent monitoring. An example of this inconsistency is a discharge permit with maximum daily effluent nutrient limits that specifies only weekly monitoring.

Compliance with probabilistic limits expressed in terms of receiving water quality may be more difficult to assess because receiving water monitoring data may need to be gathered and analyzed in order to determine whether or not compliance with water quality standards, such as a geometric mean, was achieved. Receiving water quality data are generally not gathered and analyzed as frequently as effluent monitoring data and assembly of a complete data set for an extended period, such as a year, is usually not available and analyzed until sometime in the subsequent year.

7.1.3 Benefits and Limitations

A key benefit of a probabilistic approach to nutrient discharge permitting is that it provides the ability to consider the variability in effluent and receiving water flows and concentrations. This is advantageous because the values for key parameters can be fully characterized in the development of effluent limits, rather than represented as single, extreme values. Permit development considerations are not confined to selection of the most extreme flow and concentration values commonly used in the traditional deterministic permitting process.

Using the maximum effluent concentration, or estimated maximum based on a coefficient of variation, can lead to overly restrictive nutrient limits for multiple reasons. Operational performance of nutrient removal facilities demonstrates that such maximum effluent concentrations occur infrequently. Further, the occurrence of the maximum concentration is likely to be short term, particularly in comparison to receiving water conditions and the long-term response to nutrient enrichment. Watershed nutrient impacts are not driven by short-term spikes and therefore reasonable potential analysis and water quality-based effluent calculations should be based on 95^{th} to 99^{th} percentile wastewater effluent concentrations (Bell, 2014). Actual effluent concentration probability distributions for short-term effluent variability represent viable alternatives to the EPA's TSD method for addressing effluent variability (e.g., 95% and 99% allowable for short periods) (Bell, 2014).

Probabilistic permit limits can be directly linked to satisfying receiving water quality requirements. Receiving water requirements can be expressed as either an allowable frequency of exceedance of the applicable standard, or a probabilistic representation of an acceptable downstream condition as a probability distribution rather than a single value.

Deterministic permitting approaches allow direct calculation of effluent limits. Probabilistic development of permit limits will require that permit writers use statistical characterizations of flows and concentrations and a Monte Carlo simulation to combine multiple probability distributions to calculate downstream conditions. Successive iterations of the downstream concentration calculations may be necessary to converge on an acceptable combination of effluent flows and concentrations to satisfy receiving water objectives. The data necessary for conduct of such an analysis is commonly used in deterministic permitting and includes receiving water flow data and ambient nutrient concentration data. Receiving water flow data sets are generally available covering long periods of time for most river and stream systems from sources such as USGS flow monitoring stations. Stream flow data are likely to have the greatest degree of variability and the most extreme range of minimum to maximum values of any of the data sets used in permit limit calculations. Ambient water quality data for nutrients is often available from state agency monitoring programs, watershed plans and TMDLs, and other local monitoring efforts including those conducted by wastewater utilities for receiving waters as discharge permit monitoring requirements. Computer software packages are readily available as add-ons for spreadsheet calculators to conduct the Monte Carlo simulations and can be used to conduct probabilistic permit limit calculations.

7.1.3.1 Benefits

Benefits of a probabilistic approach are summarized as follows:

- Allows consideration of the variability in effluent and receiving water flows and concentrations in the development of effluent limits.
- Provides a direct linkage with receiving water quality requirements.
- Allows direct accounting for effluent variability.
- Avoids overly restrictive effluent nutrient limits based on a combination of conservative assumptions.

7.1.3.2 Limitations

Limitations of a probabilistic approach are summarized as follows:

- Requires that the acceptable frequency of exceedance of receiving water quality target conditions be defined, as opposed to simply selecting a single, not to exceed value for the downstream concentration.
- Requires permit writers to conduct additional statistical analysis to develop effluent limits.

♦ May require successive iteration of statistical calculations to converge upon acceptable effluent concentrations to satisfy receiving water requirements.

7.1.4 Simplified Example

In this simplified example of the application of probabilistic permitting, a typical secondary treatment facility is assumed to discharge 10 mgd (15.5 cfs) to surface waters. Receiving water quality requirements dictate that reductions in phosphorus be made and that on average, downstream total phosphorus must be 0.100 mg/L. Based on statistical assessment of the receiving water river flows, a low flow of 200 cfs has been identified. However, additional data on flows and concentrations are available from which to develop discharge limits, including 11 synoptic samples of the flow from the treatment facility and the receiving water upstream of the outfall, as shown in Table 7-1. The monitoring data also include phosphorus concentrations from the receiving water upstream of the outfall. Receiving water flows vary over a wide range and are frequently higher than the low flow condition.

These data were used together to calculate the downstream mixed concentration of receiving water phosphorus. Statistically, any combination of flows and concentrations could occur. Repeated random sampling, or selection of these values, to obtain numerical results could be used. This analysis is referred to as Monte Carlo. Monte Carlo simulation may be used to combine the effluent and receiving water flow and concentration data and calculate the probability distribution for the downstream mixed conditions. Samples are chosen completely randomly across the range of the distribution. For each iteration of the calculations, values are selected at random from each of the datasets for wastewater flow and receiving water flow and upstream concentration. The calculations of allowable effluent concentration are performed and with a sufficient number of iterations, a cumulative distribution of probabilities is computed.

Table 7-1. 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)
1	16.2	200	0.099	216.2	0.10	0.1
2	15.5	1,550	0.095	1,565.5		0.6
3	14.5	1,800	0.094	1,814.5		0.8
4	15.3	2,000	0.093	2,015.3		1.0
5	14.7	2,300	0.092	2,314.7		1.4
6	14.2	2,600	0.092	2,614.2		1.6
7	15.5	2,700	0.091	2,715.5		1.7
8	14.6	3,000	0.090	3,014.6		2.2
9	14.8	3,400	0.089	3,414.8		2.6
10	15.2	4,000	0.088	4,015.2		3.3
11	15.0	5,000	0.087	5,015.0		4.4
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

In the traditional deterministic approach to permitting, the lowest river flow and highest ambient phosphorus concentration would be combined to compute the most restrictive effluent phosphorus limits. Effluent phosphorus would be limited to 0.10 mg/L in this example with the in-stream target becoming an end-of-pipe effluent limit. However, much higher effluent concentrations would be able to meet the receiving water quality target a great deal of the time on a probabilistic basis. As shown in Table 7-1, to meet an average in-stream target for phosphorus of 0.10 mg/L, an effluent limit of 1.37 mg/L would be satisfactory on a 50th percentile basis. Table 7-2 illustrates the resulting discharge permit effluent limits expressed on an average annual basis.

Table 7-2. Example of Annual Average Effluent Limitations Based on Probabilistic Analysis at 50th Percentile.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Annual Average Limit**	**Median Weekly Limit**	**Maximum Daily Limit**
Total Phosphorus as P	mg/L	1.37	–	–
	lb/day	114	–	–

7.1.4.1 Simplified Example Targeting Downstream Criteria

In some circumstances, receiving water criteria may be more restrictive and the frequency of exceedance reduced from the previous example. Using the data in Table 7-1 and the same Monte Carlo simulation, the allowable effluent discharge concentration has been calculated at the 95th percentile. The 95th percentile statistic is commonly associated with monthly effluent limits. As shown in Table 7-1, to meet the in-stream target of 0.10 mg/L on a 95th percentile basis, an effluent limit of 0.65 mg/L would be required. Table 7-3 illustrates the resulting discharge permit effluent limits expressed on a monthly average basis.

Table 7-3. Example of Monthly Average Effluent Limitations Based on Probabilistic Analysis at 95th Percentile.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Monthly Average Limit**	**Median Weekly Limit**	**Maximum Daily Limit**
Total Phosphorus as P	mg/L	0.65	–	–
	lb/day	54	–	–

7.2 Regulatory Framework for Probabilistic Nutrient Permitting

Considerations of variability in probabilistic permitting include both the basis for the targeted receiving water nutrient criteria and the variability of the parameters used in the calculation of effluent discharge limits. Receiving water nutrient criteria may be defined in probabilistic terms, such as a nutrient concentration to be achieved based on a geometric mean. Effluent and receiving flows and concentrations may also be defined in probabilistic terms, such as the lowest seven-day average flow that occurs (on average) once every 10 years (7Q10). Regulatory guidance related specifically to nutrients is limited, however permit writers' guidance provides information upon which to consider a probabilistic framework for nutrient discharge permitting.

7.2.1 Basis for Probabilistic Permits in Regulation

The federal regulations on establishing effluent limits and discharge permit conditions for WQBELs call for consideration of the variability of effluent pollutants, but provide little further specific direction on consideration of the variability in other parameters involved in permit calculations:

"When determining whether a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative or numeric criteria within a State water quality standard, the permitting authority shall use procedures which account for existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the species to toxicity testing (when evaluating whole effluent toxicity), and where appropriate, the dilution of the effluent in the receiving water." (40 CFR §122.44(d)(1)(ii)).

Permit writers' guidance provides more detailed information on probabilistic considerations in both receiving water criteria and in the parameters used in the development of discharge permit limits.

7.2.2 EPA Guidance on Interpretation of Receiving Water Nutrient Criteria

Interpretation of receiving water nutrient criteria is necessary in order to understand the basis for the criteria and whether they must be considered to be values that can never be exceeded, or whether more practically, there is a permissible frequency of exceedance that remains protective of receiving water quality. The EPA's Permit Writers' Manual makes a distinction between water quality criteria and effluent limitations (U.S. EPA, 2010). Water quality criteria are generally expressed in terms of magnitude, duration, and frequency. Effluent limits are expressed as a magnitude and an averaging period. EPA instructs permit writers to understand the underlying basis for water quality criteria when developing effluent limits:

"A permit writer should be aware of the procedures used by his or her permitting authority to appropriately reflect the magnitude, duration, and frequency components of aquatic life criteria when determining the need for and calculating effluent limitations for NPDES permits. Typically, the components of the criteria are addressed in water quality models through the use of statistically derived receiving water and effluent flow values that ensure that criteria are met under critical conditions" (U.S. EPA, 2010).

Since so much of permit writers' guidance is based on the EPA's TSD for Water Quality-based Toxics Control Basis (U.S. EPA, 1991) it is important to make a distinction between the permitting approach required for protection from toxics and the needs for management of nutrient discharges. The EPA's 1991 TSD emphasizes that water quality-based effluent limits must comply with water quality standards, even during critical conditions in the receiving water. This may be unnecessary for water quality protection from nutrient discharges. Importantly, EPA's more recent Permit Writers' Manual addresses nutrients in terms of the appropriate averaging periods for permits associated with nutrient criteria (U.S. EPA, 2010). EPA makes a distinction between criteria for toxics and considerations related to nutrient driven eutrophication. EPA indicates that states may adopt seasonal or annual averaging periods in permits to satisfy nutrient criteria instead of the much more restrictive one-hour, 24-hour, or four-day average durations necessary for protection of aquatic life from toxic pollutants.

"Some states have adopted numeric criteria for nutrients as part of their water quality standards. EPA has developed nutrient criteria recommendations that are numeric values for both causative (phosphorus and nitrogen) and response (chlorophyll a and turbidity) variables associated with the prevention and assessment of eutrophic conditions. EPA's recommended

nutrient criteria are different from most of its other recommended criteria, such as the criteria for cadmium and ammonia. First, EPA's recommended nutrient criteria are ecoregional rather than nationally applicable criteria, and they can be refined and localized using nutrient criteria technical guidance manuals. Second, the recommended nutrient criteria represent conditions of surface waters that have minimal impacts caused by human activities rather than values derived from laboratory toxicity testing. Third, the recommended nutrient criteria do not include specific duration or frequency components; however, the ecoregional nutrient criteria documents indicate that states may adopt seasonal or annual averaging periods for nutrient criteria instead of the 1-hour, 24-hour, or 4-day average durations typical of aquatic life criteria for toxic pollutants" (U.S. EPA, 2010).

7.2.2.1 Example State Interpretation of Nutrient Standards for Permitting

Some states have provided an explicit interpretation of numeric nutrient criteria that directly informs the formulation of discharge permits. For example, the state of Montana has recently adopted numeric nutrient standards for wadeable streams (Montana DEQ, 2013). The base numeric nutrient standards for Montana's flowing waters are grouped by ecoregion, either at level III (coarse scale) or level IV (fine scale) and are generally very low concentrations for both nitrogen and phosphorus. For example, Montana standards for Middle Rockies (Ecoregion III) applicable July 1st through September 30th are 30 ug/L total phosphorus and 300 ug/L total nitrogen. Montana's interpretation of nutrient criteria calls for average monthly effluent limits to be developed based on the 95th percentile of effluent concentration. Further, Montana guidance provides that the upstream receiving water may be characterized using frequency distribution percentiles. Montana guidance is summarized in the following:

"Section 2.2 Developing Permit Limits for Base Numeric Nutrient Standards

For total nitrogen and total phosphorus, the critical low-flow for the design of disposal systems shall be based on the seasonal 14Q5 of the receiving water (ARM 17.30.635(2)). When developing permit limits for base numeric nutrient standards, the Department will use an AML only, using methods appropriate for criterion continuous concentrations (i.e., chronic concentrations). Permit limits will be established using a value corresponding to the 95th percentile probability distribution of the effluent. Nitrogen and phosphorus concentrations of the receiving waterbody upstream of the discharge may be characterized using other frequency distribution percentiles. The Department shall use methods that are appropriate for criterion continuous concentrations which are found in the document "TSD for Water Quality-based Toxics Control," Document No. EPA/505/2-90-001, United States Environmental Protection Agency, 1991." (Montana DEQ, 2013).

7.2.3 EPA Guidance on Water Quality-Based Effluent Limits and Variability

EPA developed guidance for permit writers on water quality-based effluent limits (U.S. EPA, 2010) that references the approach recommended in EPA's *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA, 1991):

"If a permit writer has determined that a pollutant or pollutant parameter is discharged at a level that will cause, have reasonable potential to cause, or contribute to an excursion above any state water quality standard, the permit writer must develop WQBELs for that pollutant parameter. This manual presents the approach recommended by EPA's TSD for calculating WQBELs for toxic (priority) pollutants. Many permitting authorities apply those or similar

procedures to calculate WQBELs for toxic pollutants and for a number of conventional or nonconventional pollutants with effluent concentrations that tend to follow a lognormal distribution" (U.S. EPA, 2010).

EPA permit writers' guidance generally focuses on a single critical condition and a steady state mass balance in an effluent dilution mixing zone, as follows:

"When a WLA is not given as part of a TMDL or where a separate WLA is needed to address the near- field effects of a discharge on water quality criteria, permit writers will, in many situations, use a steady- state water quality model to determine the appropriate WLA for a discharge. As discussed in section 6.3 above, steady-state models generally are run under a single set of critical conditions for protection of receiving water quality. If a permit writer uses a steady-state model with a specific set of critical conditions to assess reasonable potential, he or she generally may use the same model and critical conditions to calculate a WLA for the same discharge and pollutant of concern" (U.S. EPA, 2010).

The EPA permit writers' guidance recognizes that for non-conservative pollutants, such as nutrients, that the steady state assumptions may be inappropriate and that more sophisticated water quality models may be more appropriate. For these circumstances, the EPA permit writers' guidance recommends that more sophisticated water quality models beyond mass balance equations are more appropriate for permitting (see Chapter 6.0).

7.2.3.1 EPA Guidance on Dynamic Modeling Using Monte Carlo Simulations

Since steady state models consider only a single condition, effluent flow and loading are assumed to be constant. Dynamic modeling is advantageous because it provides a method to explicitly predict the effects of variability in receiving water and effluent flows and concentrations. Dynamic models are described in Chapter 4.0 of the EPA TSD for Water Quality-based Toxics Control Basis (U.S. EPA, 1991). EPA recommends three dynamic modeling techniques that provide complete probability distributions for risks to be directly quantified, including Monte Carlo simulation:

"The three dynamic modeling techniques recommended by EPA for WLAs are continuous simulation, Monte Carlo simulation, and lognormal probability modeling. These methods calculate a probability distribution for receiving water concentrations receiving water concentrations (RWCs) rather than a single, worst-case concentration based on critical conditions. Prediction of complete probability distributions allows the risk inherent in alternative treatment strategies to be directly quantified. The use of probability distributions in place of worst-case conditions has been accepted practice for years in water resource engineering, where it was found to produce more cost-effective design of bridge openings, channel capacities, floodplain zoning, and water supply systems. The same cost-effectiveness can be realized for pollution controls if probability analyses are used" (U.S. EPA, 1991).

EPA identifies the ability for dynamic modeling to produce entire frequency distributions that can be used directly to inform effluent limits as an advantage over steady state modeling:

"The dynamic modeling techniques have an additional advantage over steady-state modeling in that they determine the entire effluent concentration frequency distribution required to produce the desired frequency of criteria compliance. Maximum daily and monthly average permit limits can be obtained directly from the effluent LTA concentration and CV that characterize this distribution. Generally, steady-state modeling has been used to calculate only a chronic WIA. Steady-state modeling generates a single allowable effluent value and no information about

effluent variability. If the steady-state model is used to calculate both acute and chronic wasteloads, limited information will be provided and the entire effluent distribution will not be predicted. Steady-state WLA values can be more difficult to use in permits and enforcement because of the variable nature of the receiving waterbody and the effluent. The outcome of probabilistic modeling can be used to ensure that permit limits are determined based on best probability estimates of RWCs rather than a single, worst-case condition. As a result, maximum daily and monthly average permit limits, based on compliance with water quality criteria over a 3-year period, can be obtained directly from the probability distribution" (U.S. EPA, 1991).

EPA describes Monte Carlo simulation as a combination of probabilistic and deterministic analyses where fate and transport models can be combined with inputs that are defined statistically.

"The computer selects input values from these distributions using a random generating function. The fate and transport model is repetitively run for a large number of randomly selected input data sets. The result is a simulated sequence of RWCs. These concentrations do not follow the temporal sequence that is calculated with the continuous simulation model, but they can be ranked in order of magnitude and used to form a frequency distribution. Monte Carlo analyses can be used with steady-state or continuous simulation models." (U.S. EPA, 1991)

The receiving water modeling needs to be based upon probability distributions of effluent flow and effluent concentration that appropriately match the receiving water criteria. This means that the basis for the receiving nutrient criteria must be understood (magnitude, duration, and frequency) and described in a manner that can be interpreted in terms of the level of water quality protection required of effluent limits (magnitude and averaging period), such as monthly or seasonal average, etc.

EPA summarizes the advantages of Monte Carlo simulation as follows:

- "It can predict the frequency and duration of toxicant concentrations in a receiving water.
- It can be used with steady-state or continuous simulation models that include fate processes for specific pollutants.
- It can be used with steady-state or continuous simulation models that include transport processes for rivers, lakes, and estuaries.
- It can be used with steady-state or continuous simulation models that are designed for single or multiple pollutant source analyses.
- It does not require time series data.
- It does not require model input data to follow a specific statistical distribution or function.
- It can incorporate the cross-correlation and interaction of time-varying pH, flow, temperature, pollutant discharges, and other parameters if the analysis is developed separately for each season and the results are combined." (U.S. EPA, 1991).

EPA summarizes the disadvantages of Monte Carlo simulation as follows:

- "The primary disadvantages of Monte Carlo simulation are that it requires more input, calibration, and verification data than do steady-state models, and the model results need manipulation to calculate the effluent LTA concentration." (U.S. EPA, 1991).

EPA's TSD addresses circumstances where both effluent concentration statistics will remain the same as historical effluent performance and when effluent variability is expected to change. In most cases, advanced wastewater treatment for nutrient removal will alter the statistical characteristics of effluent nitrogen and phosphorus concentrations and the variability will differ from historical effluent performance prior to the implementation of nutrient removal treatment. Chapter 5.0 of this report summarizes TPS that characterize the variability in effluent nutrient concentrations following advanced treatment for a variety of nutrient removal technologies.

7.2.3.2 EPA Guidance on Effluent Limits Using Dynamic Modeling

EPA's TSD for Water Quality-based Toxics Control Basis (U.S. EPA, 1991) presents an approach to water quality-based effluent limits based on a statistical analysis:

"To accomplish that goal, EPA has developed a statistical permit limitation derivation procedure to translate WLAs into effluent limitations for pollutants with effluent concentration measurements that tend to follow a lognormal distribution. EPA believes that this procedure, discussed in Chapter 5.0 of the TSD, results in defensible, enforceable, and protective WQBELs for such pollutants." (U.S. EPA, 2010)

Chapter 5.0 Permit Requirements of the EPA TSD describes the process of translating WLA to permit limits and accounting for variability. EPA addresses the mandatory requirements for permitting (40 CFR 122.44(d)(1)) and the discretionary elements that include procedures that account for effluent variability, existing controls on point and nonpoint sources of pollution, and available dilution. EPA recommends that permitting authorities use the statistical permit limit derivation procedure discussed in Chapter 5.0 of the TSD with the outputs from either steady state or the dynamic wasteload allocation modeling.

EPA recommends that dynamic modeling approaches be utilized when adequate supporting data are available to more exactly maintain water quality standards:

"If adequate receiving water flow and effluent concentration data are available to estimate frequency distributions, EPA recommends that one of the dynamic WLA modeling techniques be used to derive WLAs that will more exactly maintain water quality standards" (U.S. EPA ,1991).

"In general, dynamic models account for the daily variations of and relationships between flow, effluent, and environmental conditions and therefore directly determine the actual probability that a water quality standards exceedance will occur. Because of this, dynamic models can be used to develop WLAs that maintain the water quality standards exactly at the return frequency requirements of the standards." (U.S. EPA, 1991)

"Dynamic models use estimates of effluent variability and the variability of receiving water assimilation factors to develop effluent requirements in terms of concentration and variability. The outputs from dynamic models can be used to base permit limits on probability estimates of receiving water concentrations rather than worst-case conditions" (U.S. EPA, 1991).

EPA supports the application of both steady state and dynamic modeling approaches for determination of effluent limits:

"For example, permitting authorities may decide to derive water quality-based permit limits for all dischargers using a steady-state WLA model as a baseline limit determination. If time and resources are available or if the discharger itself takes the initiative (after approval by the

regulatory authority), dynamic modeling could be conducted to further refine the WLA from which final permit limits would be derived" (U.S. EPA, 1991).

The EPA TSD highlights the benefits of dynamic modeling in the derivation of permit limits and describes the approach:

"The least ambiguous and most exact way that a WLA for specific chemicals or for whole effluent toxicity can be specified by using dynamic modeling from which the WLA is expressed as a required effluent performance in terms of the LTA and CV of the daily values. When a WLA is expressed as such, there is no confusion about assumptions used and the translation to permit limits. A permit writer can readily design permit limits to achieve the WLA objectives. The types of dynamic exposure analyses that yield a WLA in terms of required performance are the continuous simulation, Monte Carlo, and lognormal probabilities analyses."

"Once the WLA is determined, the permit limit derivation procedure which can be used for both whole effluent toxicity and specific chemicals, is as follows:

- *The WLA is first developed by iteratively running the dynamic model with successively lower LTAs until the model shows compliance with the water quality standards.*
- *The effluent LTA and CV must then be calculated from the model effluent inputs used to show compliance with the water quality standards. This step is only necessary for the Monte Carlo and continuous simulation methods.*
- *The permit limit derivation procedures described in Box 5-2, Step 4 are used to derive MDLs and AMLs from the required effluent LTA and CV. Unlike these procedures for steady-state WLAs, there is only a single LTA that provides both acute and chronic and, therefore, the comparison step indicated in Figure S-4 and Box S-2 is unnecessary"* (U.S. EPA, 1991).

The EPA TSD identifies the advantages of dynamic modeling to develop effluent limits as follows:

- *It provides a mechanism for computing permit limits that are toxicologically protective. As with the procedure summarized below for two-value, steady-state WLA outputs, the permit limit derivation procedures used with this type of output consider effluent variability and derive permit limits from a single limiting LTA and CV.*
- *Actual number of samples is factored into permit limit derivation procedures. This procedure has the same elements as discussed for the statistical procedures in Option 2 below.*
- *Dynamic modeling determines an LTA that will be adequately protective of the WLA, which relies on actual flow data thereby reducing the need to rely on worst case critical flow condition assumptions.*

The EPA TSD identifies the disadvantages of dynamic modeling for use in development of effluent limits as follows:

- *Necessary data for effluent variability and receiving water flows may be unavailable, which prevents the use of this approach.*
- *The amount of staff resources needed to explain how the limits were developed and to conduct the WLA also is a concern. The permit documentation (i.e., fact sheet) will need to clearly explain the basis for the LTA and CV and this can be resource intensive.*

7.3 Using Monte Carlo Analysis for Development of Effluent Limits

Permit writers use a mass balance equation to estimate the maximum downstream concentration resulting from the discharge of a nutrient in the following equation:

$$C_d = \frac{C_u Q_u + C_e Q_e}{Q_u + Q_e}$$

The variables used to calculate the downstream mixed concentration are as follows:

Receiving water concentration downstream of the effluent discharge: C_d

Receiving water upstream flow: Q_u

Receiving water concentration: C_u

Effluent discharge flow: Q_e

Effluent discharge concentration: C_e

The variables representing the upstream flow and concentration conditions C_u and Q_u for the receiving water are generally known. The effluent discharge conditions are represented by C_e and Q_e. Permit writers conduct a reasonable potential analysis by entering critical values and computing the resulting maximum downstream concentration C_d to determine whether there is an exceedance of water quality standards. The existing effluent discharge characteristics (C_e) are generally used in the reasonable potential analysis with the design flow for the facility. If there is reasonable potential for exceedance of a water quality standard, then the permit writer can back calculate the allowable C_e limit from the same mass balance equation. While the traditional deterministic approach to calculating effluent limits is simple to implement, it produces a single number for the effluent concentration which fails to take into account the seasonal variability in the receiving water flow and concentration conditions because only critical conditions are selected for the calculation. Variability in effluent discharge conditions is accounted for by assuming a CV for the future effluent concentration and using a design flow condition.

The probabilistic approach represents each of the input variables to the mass balance equation as a probability distribution based on statistical characteristics of the observed monitoring data or by fitting observed monitoring data to a statistical distribution. The statistical characteristics or fitted distribution for each of the variables is then used to forecast values over an extended period of time. The effluent discharge concentration can be represented as either the distribution of historical effluent monitoring data, or modeled after the expected statistical performance of the planned future nutrient removal treatment facility. For each day forecasted, a value for the downstream mixed concentration of the pollutant of interest is calculated. The statistical distribution using the results of those calculations can then be determined. This resulting distribution provides estimated probabilities of the downstream concentration exceeding water quality standards and can be evaluated to determine whether the chances of exceeding a limit are acceptable or not. If not, the calculations can be repeated by successive iteration with modified effluent concentrations to arrive at an acceptable downstream concentration or distribution of downstream concentration.

To illustrate the probabilistic approach using Monte Carlo analysis, data from an example effluent discharge and receiving water are presented in the example shown in Table 7-4. In this example, daily effluent flow and phosphorus concentration data were available from period from January 1, 2010, to April 30, 2013, for a total of 1,216 observations. The effluent discharge is from a facility operating for biological phosphorus removal with an average effluent concentration slightly less than 1 mg/L. Daily observations of upstream flow were also available, however fewer receiving water phosphorus concentration observations were available, with typically only 4 to 6 samples taken each month for the same time period.

In this example, the effluent discharge is on the order of the same magnitude as the receiving water flow rate. However the receiving water flow is highly variable and ranges up to nearly three times the average, while the effluent flow is relatively constant by comparison. The phosphorus concentration of the receiving water and effluent both vary widely.

Table 7-4. Example Summary Statistics for Receiving Water Flow and Concentration Input Variables and Effluent Discharge Characteristics.

Variable	Sample Size	Mean	Median	Minimum	Maximum	Standard Deviation
Upstream Receiving Water Concentration, mg/L						
C_u	113	.185	.180	.0300	.630	.0767
Upstream Receiving Water Flow, cfs						
Q_u	1,216	18.341	11.605	2.150	51.930	14.48
Effluent Discharge Concentration, mg/L						
C_e	212	.932	.500	.110	4.65	.991
Effluent Discharge Flow, cfs						
Q_e	1,216	5.345	5.270	3.270	6.93	.529

Since each variable consists of observations taken over time, each one represents a time series. With any time series, the effects of seasonality need to be assessed. The distributions which could describe the patterns in the daily observations assume that each observation is independent of another. When seasonality is present, this assumption may not hold. With seasonality, a high value in one month generates a high value in the subsequent month or conversely, a low value in one month generates a low value in a subsequent month. In the data sets for this example, all series appear to be in an average steady state over time with the exception of the concentration of the upstream receiving water phosphorus data.

The impact of seasonality can be observed by pooling the data by month, which shows that the lower receiving water flows and higher phosphorus concentrations over the months May to September reflect the impact from irrigation practices. Statistical inferential tests can be used to show that the distributions and their respective means are different in the non-irrigation and irrigation seasons. Since the receiving water distributions differ with season, the calculation of effluent limits should also be conducted by season.

A Monte Carlo simulation with the @Risk application and the distributions shown in Table 7-4 for receiving water flow and concentration data, and effluent flow and concentration data, was used to randomly generate 10,000 future observations of the downstream mixed concentration of phosphorus C_d during the irrigation and non-irrigation seasons. Table 7-5 summarizes the statistics from the Monte Carlo simulation of downstream phosphorus concentration. During the irrigation season, the effluent discharge of approximately 1 mg/L effluent phosphorus results in a downstream 50th percentile of exceedance concentration of 0.21 mg/L and a 95th percentile concentration of 0.47 mg/L.

Table 7-5. Summary Statistics from Monte Carlo Simulation of Downstream Phosphorus Concentrations Resulting from Biological Phosphorus Removal Effluent Concentration of ~1 mg/L.

Season	Percentile Exceedance of Downstream Phosphorus Concentration in mg/L			
	50%	90%	95%	99%
Irrigation	0.21	0.39	0.47	0.73
Non-Irrigation	0.44	1.1	1.4	2.16

7.3.3.1 Convergence to Effluent Concentrations Meeting Downstream Criteria

When the modeled distribution of downstream concentrations of phosphorus exceeds the applicable in-stream criteria, the effluent concentration is not acceptable and must be reduced. That is, the incidence of exceedance has surpassed an acceptable probability of exceedance for the water quality criteria. In this example, should the irrigation season in-stream criteria be required to be lower on average (<0.21 mg/L), or at the 95th percentile (<0.47 mg/L), then the effluent discharge concentration of ~ 1 mg/L in Table 7-5 would need to be reduced and the calculations repeated until an acceptable effluent concentration distribution was determined.

Multiple iterations may be required to find both the optimal distribution for downstream phosphorus concentrations and an acceptable distribution of effluent concentrations. Monte Carlo simulations can be conducted by successive trials, or by programming logic using applications such as @RISK with RiskOptimizer to run through a range of distributions of daily downstream concentrations to study the impact on modeled daily effluent concentrations.

The technology performance statistics presented in Chapter 5.0 provide statistical characteristics describing a variety of nutrient removal processes that can be used as references to model future effluent conditions in Monte Carlo simulations for conditions following nutrient removal upgrades. Total maximum daily loads may provide information on the frequency of wasteload allocations necessary to satisfy in-stream targets. In many cases the receiving water criteria are vaguely defined and must be interpreted, such as by assuming seasonal averages, or some other acceptable frequency of exceedance. In other cases, such as the example presented earlier for Montana nutrient criteria, the 95th percentile of effluent concentration is referenced in state standards.

A lower in-stream target than calculated in the example, would mean reducing the effluent phosphorus concentration below the ~1 mg/L average in Table 7-5. Monte Carlo simulations can be run to determine the effluent concentration for an in-stream 50th percentile target value of 0.200 mg/L. The effluent concentration could maintain the same statistical characteristics except that the mean concentration would need to be reduced from about ~1 mg/L to 0.57 mg/L. The in-stream target in this example could not be reduced much further below 0.200 mg/L without the in-stream target becoming the effluent concentration limit at the end-of-pipe, because there is not enough ambient receiving water flow at sufficiently low phosphorus concentration to dilute the effluent. Highlighting this limitation is the average receiving water phosphorus concentration of 0.185 mg/L.

7.4 Example Monte Carlo Analysis

Example situations with a discharge to a Rocky Mountain stream were selected to investigate using the Monte Carlo analysis. Long-term stream flow records were acquired from the nearest USGS gaging station. Phosphorus and/or nitrogen concentrations were also acquired from the USGS. The mean, standard deviation, minimum and maximum were computed in a spreadsheet. Historical wastewater facility measurements of effluent and phosphorus and/or nitrogen were acquired from the operator. Again, the mean, standard deviation, minimum and maximum were computed in a spreadsheet. These values were then used in the @Risk software with the spreadsheet to define the distributions. The mass balance equation was written with references to each of the distributions. The @Risk software was the used to simulate the results of mass balance equation for 10,000 iterations.

Based on USGS records, the Boise River near Boise, Idaho, has river flow and ambient concentrations characterized as shown in Table 7-6. The phosphorus target concentration is 0.070 mg/L based on a downstream TMDL for the Snake River which the Boise River flows into near Parma, Idaho. A wastewater treatment facility discharging at a flow rate similar to the largest facilities in the area and with assumed advanced treatment of phosphorus was examined.

The effluent flow and concentration values used in the calculations are shown in Table 7-7. The data suggests there is additional receiving water capacity for discharge flow and/or phosphorus loading while still remaining below the phosphorus target concentration. The Monte Carlo analysis was completed with three targets to illustrate the impact that the basis for the receiving water phosphorus criteria has on the acceptable level of effluent phosphorus: 1) receiving water 50th percentile at 0.07 mg/L, 2) receiving water 95th percentile at 0.07 mg/L, and 3) end-of-pipe effluent concentration set at the in-stream target of 0.07 mg/L. The phosphorus concentration distribution in the river upstream and downstream of the wastewater facility is shown in Figure 7-1. The @Risk plot shows the log-normal probability distribution of the upstream and downstream concentrations. Phosphorus concentrations are shown on the x-axis. The upstream distribution is based on the mean, standard deviation, minimum, and maximum of the upstream monitoring data (Table 7-6 and Figure 7-1 in blue). The four distributions (Table 7-6 receiving water and Table 7-7 effluent) are combined in the @Risk Monte Carlo simulation to calculate the downstream concentration distribution (Figure 7-1 in red). The statistics of the probability distribution can then be used to inform permitting decisions, as summarized in Table 7-8.

Table 7-6. Receiving Water River Flow and Upstream Phosphorus Conditions.

Parameter	Mean	Standard Deviation	Minimum	Maximum
River Flow (cfs)	1,183	1,663	86	9,560
Upstream Phosphorus (mg/L)	0.029	0.018	0.010	0.090

Table 7-7. Effluent Flow and Future Phosphorus Concentrations Based on Biological Phosphorus Removal and Chemical Coagulation and Filtration.

Parameter	Mean	Standard Deviation	Minimum	Maximum
Plant Flow (cfs)	8.33	0.94	5.06	12.92
Effluent Phosphorus (mg/L)	0.11	0.17	0.01	2.00

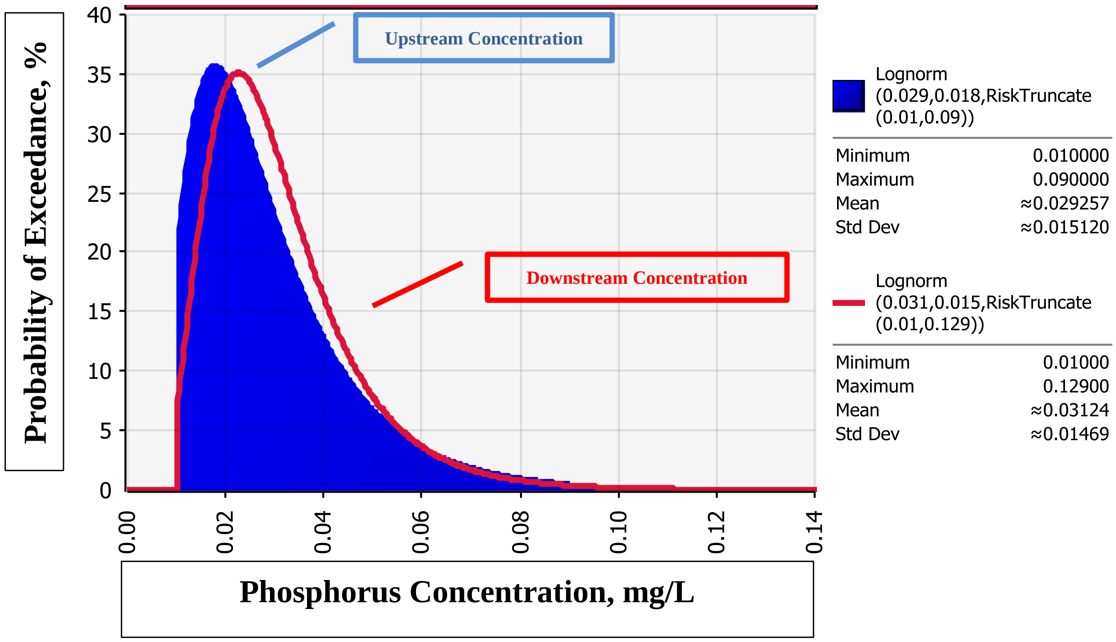

Figure 7-1. Upstream (Blue) and Downstream (Red) Phosphorus Concentrations (X-axis) Probability Distribution (Y-Axis).

Table 7-8 shows that if the receiving water target of 0.070 mg/L is interpreted as a 50th percentile value, that the mean effluent discharge concentration can be as high as 3.3 mg/L. If the receiving water target of 0.07 mg/L is required to be satisfied on a 95th percentile basis, then the effluent concentration can average 0.42 mg/L.

Table 7-8 also shows that if the effluent is required to be the same concentration as the in-stream target at the end-of-pipe, then the resulting downstream concentration will be much lower than the criteria the vast majority of the time. The median (50th percentile) downstream concentration will be 0.026 mg/L. An effluent concentration of 0.070 mg/L results in a 95th percentile downstream concentration of 0.061 mg/L.

Table 7-8. Summary Statistics from Monte Carlo Simulation of Downstream Phosphorus Concentrations Resulting from Alternative Effluent Phosphorus Levels.

Effluent Phosphorus Characteristics	Percentile Exceedance of Downstream Phosphorus Concentration in mg/L	
	50%	95%
Mean 3.3 mg/L, Std Dev 0.17 mg/L	0.070 mg/L	0.204 mg/L
Mean 0.42 mg/L, Std Dev 0.17 mg/L	0.033 mg/L	0.070 mg/L
Mean 0.07 mg/L, Std Dev 0.17 mg/L	0.026 mg/L	0.061 mg/L

CHAPTER 8.0

WATERSHED NUTRIENT PERMITTING

Watershed-based NPDES permitting is a process that emphasizes addressing all stressors within a hydrologically defined drainage basin, rather than addressing individual pollutant sources on a discharge-by-discharge basis. Watershed-based permitting can encompass a variety of activities, ranging from synchronizing permits within a basin to developing water quality-based effluent limits using a multiple discharger modeling analysis. The type of permitting activity will vary depending on the unique characteristics of the watershed and the sources of pollution impacting it. The ultimate goal of this effort is to develop and issue NPDES permits that better protect entire watersheds (U.S. EPA, 2014c).

EPA has published a significant amount of information pertaining to a watershed approach to permitting (e.g., U.S. EPA, 1996b; U.S. EPA, 2003a; U.S. EPA, 2007a). The purpose of this chapter is to address EPA policy statements and provide case studies that provide insight to nutrients and NPDES permitting with regards to the watershed permitting approach.

Care should be taken in the formulation of watershed permits to avoid over-specifying effluent limits in ways that may create unintended disincentives to reducing nutrients. An example is when technology-based limits and water quality-based limits are both included in the same permit for the same parameter. Technology-based effluent limits may act as a disincentive to improve treatment because better performance can result in more stringent technology limits. Chapter 9 provides another example of circumstances where disincentives to improving effluent performance can be created inadvertently.

8.1 EPA Policy

EPA released four policy statements regarding watershed-based NPDES permitting during the 2002 to 2003 period. These policy statements are summarized and their relevance to nutrient discharge NPDES permitting is discussed in this section.

In December 2002, EPA Office of Water Assistant Administrator Mehan released the memorandum titled "Committing EPA's Water Program to Advancing the Watershed Approach" to office directors and regional water division directors (Mehan, 2002). Mehan argued that although the watershed approach had been embraced by EPA for nearly a decade, substantial gaps in actual implementation existed. The memorandum announced creation of a Watershed Management Council with the charge of implementing a series of specific issues with respect to the watershed approach including:

- Integrating and focusing internal EPA programs.
- Funding local watershed strategies and building local capacity.
- Providing assistance to States and Tribes.
- Fostering innovations.

As part of the last issue, Mehan requested that efforts to develop and issue NPDES permits on a watershed basis be accelerated. Specifically, Mehan asked the Office of Wastewater Management to issue the watershed-based permitting policy statement and to work with the Regions to accomplish the following:

"Develop and implement a "roadmap" for advancing watershed-based NPDES permitting activities. Implement the watershed-based NPDES permitting policy immediately in those Regions that administer the NPDES permit program. Have regions identify watershed-based permit case studies; if no regional examples already exist, create watershed-based pilots. Include watershed-based permitting approaches as priority decision criteria for Water Quality Cooperative Agreement funding. Characterize the permit universe to determine permits or groups of permits that may be a high priority for reissuance based on watershed specific goals, impacts, and specific results."

In January 2003, EPA Office of Water Assistant Administrator Mehan released the memorandum titled "Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Policy Statement" to regional water division directors (Mehan, 2003a). In the memorandum Mehan states:

"For this Policy, watershed-based permitting is defined as an approach that produces NPDES permits that are issued to point sources on a geographic or watershed basis to meet watershed goals. This policy statement communicates EPA's policy on implementing NPDES permitting activities on a watershed basis, discusses the benefits of watershed-based permitting, presents an explanation of the process and several mechanisms to implement watershed-based permitting, and outlines how EPA will be encouraging watershed-based permitting."

Mehan emphasized that the recommendations in the memorandum are not binding and that the memorandum does not substitute for provisions or regulations (i.e., CWA and EPA's NPDES implementing regulations).

In May 2003, EPA released the document "Watershed-Based NPDES Permitting: Rethinking Permitting as Usual." The document (U.S. EPA, 2003b) is a summary fact sheet describing the process and differs from the memoranda because specific nutrient case studies are mentioned.

In December 2003, EPA Office of Water Assistant Administrator Mehan released the memorandum titled "Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance" to regional water division directors (Mehan, 2003b). This memorandum provided the implementation guidance document as an attachment, and also referenced the December 2002 and January 2003 memoranda. The implementation guidance focuses on program implementation, but not technical, procedural, or administrative actions related to permit issuance. Mehan indicated that the Office of Wastewater Management would work with regional directors and the states to develop the technical guidance.

8.1.1 Analysis of EPA Policy

The four documents from EPA on watershed permitting lay the foundation for a watershed framework for NPDES permitting, but provide flexibility for state permit writers by not dictating a "one size fits all" type of framework. Watershed goals are often mentioned, implying that TMDLs and/or WQS are necessary. This suggests that a given state has developed nutrient TMDLs and/or WQS that result in the need for nutrient discharge permitting in a given watershed.

8.2 Case Study Examples

EPA has provided several examples of watershed-based NPDES permitting (U.S. EPA, 2014c). This section presents a discussion of seven watershed permitting examples, including a new approach from the San Francisco Bay area that represents the most recent application of watershed permitting for nutrients.

8.2.1 Tualatin River and Clean Water Services

The Tualatin River Basin, located in northwestern Oregon and west of Portland, is a 712 square mile subbasin of the Willamette River (U.S. EPA, 2007d). The only major discharger in the basin is Clean Water Services (CWS) which operates the municipal wastewater treatment facilities. More than 20 small treatment plants in the watershed were consolidated in the mid-1970s into two larger facilities (Rock Creek and Durham), which provide advanced wastewater treatment including phosphorus removal. However, advanced treatment and river flow improvements to the Tualatin were not sufficient to meet all water quality standards and support beneficial uses.

In 1988 TMDLs were established for ammonia and TP to address low DO and high pH levels in the Tualatin. While the ammonia TMDL addressed low DO levels, the phosphorus TMDL addressed nuisance algal growth and accompanying high pH levels. The TMDLs were updated in 2001 and expanded to include new parameters (water temperature, bacteria, and DO in tributaries).

In the late 1990s and early 2000s, several individual NPDES permits were expiring, allowing a unique opportunity for the Oregon Department of Environmental Quality (DEQ) to consolidate CWS's permits for four wastewater facilities and their stormwater discharges with the Municipal Separate Storm Sewer System (MS4) permit into a single watershed NPDES permit (Oregon DEQ, 2004). Oregon DEQ issued a single, watershed-based, integrated NPDES permit to CWS. This permit incorporates the NPDES requirements for four advanced wastewater treatment facilities, one MS4 permit, and individual storm water permits for the Durham and Rock Creek Advanced Wastewater Treatment Facilities. The introduction to the permit highlights the benefits of this permit structure with the following:

"This represents a change in the traditional approach to regulatory management of the watershed by integrating several program elements of the CWA into a single document along with water quality trading. This combination allows 1) greater coordination of watershed protection and enhancement programs, 2) greater coordination of watershed assessment and monitoring activities, and 3) greater public involvement."

This permit also included language to pursue water quality credit trading for dissolved oxygen and water temperature (but not phosphorus).

In 2012, a revised TMDL to address dissolved oxygen and phosphorus also includes creation of a new phosphorus trading program (Oregon DEQ, 2012). Phosphorus WLAs for the treatment facilities were revised, and trading of phosphorus load among the facilities will be implemented under the reissued watershed permit. The 2012 amendment to the 2001 TMDL provides new phosphorus allocations for the Forest Grove and Hillsboro discharge locations, and provides daily load equivalents for the monthly targets set out in the 2001 TMDL (WLAs for the Rock Creek and Durham facilities are unchanged from the 2001 TMDL). The 2012 TMDL update provides a bubble allocation as a daily load for the Forest Grove, Hillsboro, and Rock Creek facilities, which places a ceiling on the allowable discharge load from multiple sites combined. The bubble allocation will provide CWS with the flexibility to adopt innovative treatment at one, or both, of the upstream treatment plants, knowing that minor variations in phosphorus treatment at the upstream plants can be offset by proven advance treatment technology already in place at the Rock Creek facility (Oregon DEQ, 2012).

The watershed NPDES permit (Oregon DEQ, 2004) was updated (Oregon DEQ, 2012) to include creation of a new total phosphorus trading program. The phosphorus WLAs for the wastewater facilities were revised and trading of phosphorus loads among the wastewater facilities will be implemented under the reissued watershed permit:

"This TMDL amendment is also designed to accommodate some phosphorus "trading" between CWS' two small upstream plants and their large Rock Creek wastewater treatment plant. The TMDL sets a "bubble" waste load allocation for all three plants that ensures the TMDL target for phosphorus will be met in the lower Tualatin River. It also provides flexibility to the wastewater treatment facilities, allowing waste to be directed to more than one of the treatment plants, depending on treatment capacity at each plant."

The 2012 amendment to the 2001 TMDL provides new total phosphorus allocations for the Forest Grove and Hillsboro discharge locations, and provides daily load equivalents for the monthly targets set out in the 2001 TMDL (Oregon DEQ, 2012). Wasteload allocations for the Rock Creek and Durham facilities will remain the same as the 2001 TMDL. While the Forest Grove and Hillsboro facilities were online at the time of the 2001 TMDL, they had not been discharging during the summer months. Instead, during the summer, raw wastewater from these treatment plants are conveyed to the Rock Creek facility. As population in the Tualatin Basin increases, CWS proposes (Oregon DEQ, 2012) to increase treatment capacity by maintaining the current capacity at its two downstream facilities, the Rock Creek and Durham plants, and by commencing summertime discharges at its two upstream facilities at Forest Grove and Hillsboro (along with proposed plant upgrades to reduce nutrients prior to summer discharge). The Rock Creek and Durham facilities will increase capacity as needed once Forest Grove and Hillsboro are operating at full capacity during the summer.

The 2012 TMDL update provides a bubble allocation as a daily load for the Forest Grove, Hillsboro, and Rock Creek facilities as shown in Table 8-1. A bubble load places a ceiling on the allowable discharge load from multiple sites combined. Phosphorus discharged from these three sites combined must not exceed 66.1 pounds per day as a seasonal median value (the daily target is 232 pounds per day, and the average monthly limit is 81.6).

Table 8-1. Tualatin River TMDL Phosphorus Bubble Load Allocations.

Bubble Loads: Forest Grove, Hillsboro, and Rock Creek WWTPs[1]	
≤ 66.1 lbs/day as a seasonal median ≤ 232 lbs/day as a daily maximum ≤ 81.6 lbs/day as an average monthly limit[1]	May 1 – Sept 30[2]
Wasteload Allocation: Rock Creek WWTP	
Monthly Median TP: 0.10 mg/L Daily Maximum TP: 0.24 mg/L	May 1 – Sept 30[2]
Wasteload Allocation: Durham WWTP	
Monthly Median TP: 0.11 mg/L Daily Maximum TP: 0.26 mg/L	May 1 – Oct 15[2]

[1]The monthly median effluent load will be calculated as follows: [(8.35 conversion factor)×(((Median monthly Forest Grove TP mg/L)×(Actual median Forest Grove volume mgd))+((Median monthly Hillsboro TP mg/L)×(Actual median Hillsboro volume mgd)))] ≤[Monthly median load (81.6 pounds per day) - ((Monthly median Rock Creek TP mg/L)×(Actual monthly median Rock Creek volume mgd) ×(8.35 conversion factor))].
[2]TMDL Phosphorus restrictions may change as early as September 15 in years when Lake Oswego Corporation ceases Tualatin River withdrawals on or before September 15, and the weekly average flow at the Farmington gauge is at least 130 cfs.
Source: (Oregon DEQ, 2012).

A median discharge concentration limit of 0.10 mg TP/ L must concurrently be met at the Rock Creek facility. Monthly limits can also be calculated for the bubble load, and may be of use for permitting, as permits require monthly performance reporting. This conversion must also take into account the number of discharge samples taken in a month (Oregon DEQ, 2012). Using a value of 0.6 for the coefficient of variance, and 20 discharge samples taken per month during summer, the phosphorus bubble waste load allocation is 81.6 lbs/day as a monthly average (calculations were based on a method developed by U.S. EPA Region 10). While equivalent daily targets have been added to this amendment, the renewed watershed NPDES permit will likely be based on the monthly or seasonal targets (Oregon DEQ, 2012).

The bubble allocation will provide CWS with the flexibility to adopt innovative treatment at one or both of the upstream treatment plants, knowing that minor variations in phosphorus treatment at the upstream plants can be offset by proven advanced treatment technology already in place at the Rock Creek Plant (Oregon DEQ, 2012). This type of trading, also called intra-municipal trading, allows Clean Water Services to manage multiple discharges as a system, apportioning a total load among multiple facilities. In this case, DEQ has already issued a watershed permit that includes all four discharges under a single permit order. Describing the phosphorus allocation as a bubble load in this TMDL will enable the permit writer to incorporate intra-municipal trading in subsequent watershed permits for CWS. One requirement for this type of trade is a demonstration that localized impacts are not expected at any of the discharge locations (Oregon DEQ, 2012).

8.2.2 Long Island Sound, New York and Connecticut

Low DO levels in Long Island Sound have been attributed to excess nitrogen originating from New York and Connecticut. Both states collaborated to develop a nitrogen TMDL to achieve each state's respective water quality standards (Connecticut DEEP, 2000). In Connecticut, 79 publically owned treatment works (POTWs) were issued a nitrogen WLA. A nitrogen general NPDES permit and a Nitrogen Credit Exchange Program were developed in 2002. The general permit addresses TN discharges from the 79 POTWs and sets TN limits for each facility. The exchange program was developed to allow purchase of credits for POTWs that have difficulty meeting their individual TN limits.

The general permit for Connecticut POTWs was reissued for the 2011-2015 period (Connecticut DEEP, 2010). Annual discharge limits (pounds/day) were issued based in part on how far an individual POTW was located from the Long Island Sound via an "equivalency factor", which means a ratio of the unit response of dissolved oxygen to nitrogen in Long Island Sound for each POTW based on the geographic location of the specific POTW's discharge point divided by the unit response of the geographic area with the highest impact. The 2015 WLAs for each POTW are equivalent to the final WLAs set forth in the TMDL (Connecticut DEEP, 2000).

Table 8-2 summarizes the annual total nitrogen discharge from a select group of Connecticut facilities from each of the six zones in the general permit for nitrogen discharges. The table illustrates the nitrogen loadings and the equivalency factors assigned to individual dischargers. The annual discharge limits are expressed in pounds per day allocated at the end-of-pipe from each facility. Compliance with the annual discharge limits is based either discharging less than the mass in the general permit, or by securing nitrogen credits equivalent to the amount exceeding the annual discharge load assigned to an individual facility. The limits are subject to revision in the course of the permit as new information becomes available about the achievement of the aggregate wasteload allocation for the Long Island Sound TMDL.

Table 8-2. Annual Discharge Limits for Select Facilities Under Connecticut General Permit for Nitrogen Discharges.
Connecticut DEEP, 2010.

Zone	Publicly Owned Treatment Works	Equivalency Factor	Total Nitrogen (Pounds/Day)				
			2011	2012	2013	2014	2015
1	New London WPCF	0.18	**424**	**404**	**395**	**386**	**386**
2	Hartford WPCF	0.20	**2,611**	**2,491**	**2,431**	**2,377**	**2,377**
3	New Haven East WPCF	0.60	**1,722**	**1,643**	**1,603**	**1,568**	**1,568**
4	Waterbury WPCF	0.60	**1,109**	**1,058**	**1,049**	**1,049**	**1,049**
5	Bridgeport West WPCF	0.85	**1,144**	**1,091**	**1,065**	**1,041**	**1,041**
6	Stamford WPCF	1.00	**1,017**	**970**	**947**	**926**	**926**

The Connecticut Department of Energy and Environmental Protection (DEEP) purchases all of the equivalent nitrogen credits generated by facilities that achieve compliance and discharge less than their nitrogen load limit. The number of equivalent nitrogen credits required to achieve compliance is calculated by subtracting the annual mass loading of nitrogen discharged by a facility from the annual mass loading limit and multiplying the result by the equivalency factor for the facility. Facilities must purchase the equivalent nitrogen credits needed to achieve a zero equivalent nitrogen credit balance by July 31 to remain in compliance with the permit.

Progress towards the 2014 TMDL goal of 9,141 pounds of TN discharged from the 79 POTWs since 2002 is promising. In 2002 the load totaled over 15,000 pounds TN, while a recent report (Connecticut DEEP, 2013) indicated that the load measured in 2012 was reduced to 8,246 pounds TN. It was noted that 2012 was the warmest year on record since 1895 for the northeast and the warm weather enhanced nitrogen removal in the treatment facilities and resulted in a decrease in the nitrogen discharge.

The Connecticut Nitrogen Program includes requirements for monitoring and reporting in the General Permit for Nitrogen Dischargers. Figure 8-1 illustrates the Nitrogen Analysis Report that is required to be submitted each month to the Connecticut DEEP and serves as the basis for calculating compliance with the General Permit.

Nutrient Analysis Report

For compliance with General Permit for Nitrogen Discharges

Facility Name: WEST HAVEN WPCF | **Month:** Jun-15

Permit Number: CT0101079 | **Design Flow:** 12.5MGD

Final Effluent

Plant Name	Sample Date (mm/dd/yyyy)	Average Daily Flow (mgd)	TKN (mg/l)	(Nitrite + Nitrate) (mg/l)	Total Nitrogen (mg/l)	Total Nitrogen (lbs/d)
WEST HAVEN W	6/1/2015	5.2	1.5	2.3	3.8	165
WEST HAVEN W	6/2/2015	5.5	1.4	2	3.4	156
WEST HAVEN W	6/8/2015	4.7	1.6	2.7	4.3	169
WEST HAVEN W	6/9/2015	4.7	1.7	2.2	3.9	153
WEST HAVEN W	6/15/2015	5.9	2.1	2.6	4.7	231
WEST HAVEN W	6/16/2015	5	1.6	2.7	4.3	179
WEST HAVEN W	6/22/2015	5	0.9	1.7	2.6	108
WEST HAVEN W	6/23/2015	5.2	1.1	1.6	2.7	117
WEST HAVEN W	6/29/2015	5.4	1.4	2.3	3.7	167
WEST HAVEN W	6/30/2015	5.2	0.8	1.4	2.2	95
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					0	0
					Total Pounds	1540
					Average Pounds	154

Date of Last Calibration of Flow Meter: 13-Apr-15

Statement of Acknowledgement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

Authorized Official: William C. Norton **Title:** Administartor WPCC

Figure 8-1. Nitrogen Analysis Report.

8.2.2.1 Stamford, Connecticut Permit

The City of Stamford Water Pollution Control Authority NPDES permit is included under Connecticut's General Permit for Nitrogen Discharges. The equivalency factor for Stamford's facility is 1.00, as shown in Table 8-2. The Stamford NPDES permit specifies nitrogen monitoring, as summarized in Table 8-3, but does not specifically identify the annual nitrogen load allocation for Long Island Sound.

Table 8-3. City of Stamford, Connecticut NPDES Permit Structure for Nitrogen

Permit ID: CT0101087 Expires June 24, 2018.

Parameter	Units	Flow/Time Based Monitoring			
		Average Monthly Limit	Maximum Daily Limit	Sample Frequency	Sample Type
Nitrogen, Ammonia November – May June - October	mg/L	NA 2	– –	Weekly 3/Week	Daily Composite
Nitrogen, Nitrate	mg/L	NA	–	Monthly	Daily Composite
Nitrogen, Nitrite	mg/L	NA	–	Monthly	Daily Composite
Nitrogen, Total Kjeldahl	mg/L	NA	–	Monthly	Daily Composite
Nitrogen, Total	mg/L	NA	–	Monthly	Daily Composite
Nitrogen, Total	lbs/day	NA	–	Monthly	Daily Composite

8.2.3 Jamaica Bay Watershed, New York

Jamaica Bay is located at the southern end of Brooklyn and Queens, and abuts the JFK airport. The Bay has experienced dissolved oxygen water quality standard violations associated with ongoing hypoxia issues. The primary driver of the hypoxia is nitrogen input from the watershed. Four major New York City wastewater treatment plants discharge into Jamaica Bay (Coney Island, Jamaica, Rockaway, and 26th Ward). To address the hypoxia issue, the four treatment plants are subject to a total nitrogen limit that is imposed through the First Amended Nitrogen Consent Judgment (New York Supreme Court, 2011). The limit is an aggregate 12-month rolling average mass limit, with incremental TN limits to be implemented as performance-based limits following completion of treatment plant upgrades which provide biological nitrogen removal (Table 8-4). The performance-based total nitrogen limits incrementally step down in phases 19 months after commencement of operations of the upgraded facilities. The schedule for wastewater treatment plant upgrades is outlined in a compliance schedule (New York Supreme Court, 2011), which anticipates completion of upgrades for the Jamaica and 26th plants by 2016, and completion of upgrades for the Rockaway and Coney Island plants by 2020.

Table 8-4. Total Nitrogen Interim Effluent Limits.

NYSDEC, 2013.

Effective Date	**Jamaica Bay Limits** – These interim limits are step-down aggregate limits for all four Jamaica Bay WWTPs, expressed as a 12 month rolling average.
November 1, 2009	41,600 lbs/day
January 1, 2012 (19 months after commencement of operation of the Level 2 upgrade at the 26th Ward WWTP on June 1, 2010).	36,500 lbs/day
19 months after commencement of operation of the interim chemical addition facility for AT#3 at the 26th Ward WWTP.	Performance-Based Limit.
19 months after the last of commencement of: (a) the Level 3 BNR upgrades at the 26th Ward WWTP, or (b) the Level 2 BNR upgrades at the Jamaica WWTP.	Performance-Based Limit.
19 months after the last of: (a) construction completion of the Level 1 BNR upgrade at Coney Island WWTP; or (b) construction completion of the Level 1 BNR upgrade at the Rockaway WWTP.	Performance-Based Limit.

A final aggregate nitrogen limit of 7,400 lbs/day was established for the four Jamaica Bay treatment plants (NYSDEC, 2013). A comprehensive report (NYC DEP, 2006) determined that the nitrogen discharges from the four treatment plants would have to be equal, or close to zero, in order to attain water quality standards for dissolved oxygen. The aggregate limit was calculated from the current limit of technology for nitrogen treatment which reflects a concentration of 3.0 mg/L and a projected flow of 296 mgd for the four Jamaica Bay plants in 2045. The report was approved by the NYC DEC and the projected 2045 flows were used in additional modeling efforts for projected performance to include impacts from population increases.

8.2.4 Chesapeake Bay Watershed, Virginia

In 2000 the states in the Chesapeake Bay watershed signed an agreement to reduce nitrogen and phosphorus loads into the Bay (Chesapeake Bay Program, 2000), with wasteload allocations assigned to major river basins in each state. The Virginia DEQ developed strategies for each of its tributaries entering the Bay (Eastern Shore, Potomac, Rappahannock, York, and James), assigning nutrient load allocations to both point and nonpoint sources. A watershed-based general permit was developed to encompass 125 dischargers in 2006 (U.S. EPA, 2007; Virginia DEQ, 2014a), as well as a nutrient trading program.

A "delivery factor" has been assigned to each of the dischargers, much like was done for Connecticut with respect to "equivalency factors". For a given facility, different delivery factors are assigned for TN and TP. To date, all five river basins have met and exceeded their WLAs assigned in the general permit for TN, TP, as well as TSS. It is anticipated that the existing general permit will be extended.

Dischargers have two basic options for compliance, either directly meet their annual wasteload allocation for N and P in their discharge, or obtain N and P credits to offset N and P loads exceeding their wasteload allocations. Effluent limits in the permit are set as annual wasteload allocations (i.e., lbs/yr of TN and TP). Concentration limits typically are included in individual VPDES permits when the treatment plant has received state Water Quality Improvement fund grants of revolving load funds to construction nutrient removal upgrades. The concentration limits are set as annual average mg/l limits and are technology-based and depend upon what the wastewater utility indicates to the state that the treatment process is designed to achieve. The technology-based concentration limits are used to ensure that the facility is operating the nutrient removal process as intended. Since most discharge flows are below the plant design flow (upon which the wasteload allocation is based), concentration-based limits also help ensure that dischargers are able to generate nitrogen and phosphorus credits for trading.

In 2010 EPA finalized the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment (U.S. EPA, 2010a). As part of compliance requirements, each state in the watershed is required to develop Phase I and Phase II Watershed Implementation Plans (WIPs), which contain details on how each state intends to implement TMDL provisions in their own NPDES permitting programs and consider trading and other strategies. For example, the Virginia Phase I WIP (Virginia DEQ, 2010) included creation of a watershed cap on nutrient loads from significant point source dischargers. The Virginia Phase II WIP (Virginia DEQ, 2012) focuses primarily on agricultural, stormwater, and septic issues, but also reports on the expansion of the nutrient credit trading program. Regarding wastewater, the Phase II WIP provides some technical changes to Phase I WIP strategies and presents an updated approach for permitting of combined sewer overflows (CSOs).

8.2.4.1 Nutrient Exchange

The Virginia State Water Control Board issued a general VPDES watershed permit for total nitrogen and total phosphorus discharges and nutrient trading in the Chesapeake Bay watershed in Virginia. The general permit establishes annual effluent loading limits for nitrogen and phosphorus, and establishes the conditions by which credits (the difference in pounds between the facility's limit and the mass actually discharged) may be exchanged, or offsets (an alternate nutrient removal mechanism) may be purchased by existing facilities that have exceeded their allocation, or by new and expanded facilities not assigned a waste load allocation.

The Virginia Nutrient Credit Exchange uses voluntary, market-based nutrient credit trading as a means of achieving compliance and prepares an annual update to the Chesapeake Bay Nutrient Credit Exchange Program Compliance Plan. The initial focus of the Exchange was on nutrient removal upgrades for compliance with the Chesapeake Bay nitrogen and phosphorus waste load allocations. Since compliance was achieved in 2011 the focus has shifted to maintaining compliance through an ongoing program of additional facility upgrades.

Virginia DEQ is required to prepare a report on the total annual mass loads of nitrogen and phosphorus discharged to the Chesapeake Bay watershed by each permitted facility by April 1st of each year. The actual loads and delivered loads are identified for each discharger and compared with the corresponding wasteload allocation. Virginia DEQ determines the number of point source nitrogen and phosphorus credits generated, or required, by each facility in the previous calendar year. If there are insufficient point source credits available for exchange to provide for full compliance by every permittee, then DEQ determines the number of credits to be purchased from the Water Quality Improvement Fund.

8.2.4.2 HRSD Bubble Permit Example

Table 8-5 presents an example of the annual loading analysis for the Hampton Roads Sanitation District (HRSD) facilities discharging to the James River in 2013. HRSD has a “bubble” allocation for 7 facilities discharging to the James River in the Chesapeake Bay watershed. These facilities have an aggregated mass load limit referred to as an “owner bubble” and compliance is determined on an aggregate basis rather than by comparison of individual facility loads with respective individual WLAs.

Table 8-5. Hampton Roads Sanitation District (HRSD) 2013 Nitrogen and Phosphorus Wasteload Allocations and Delivered Loadings for the James River.

		Total Nitrogen			Total Phosphorus		
Facility	**Design Flow, mgd**	**Wasteload Allocation, lbs**	**Delivery Factor**	**2013 Discharged Load, lbs**	**Wasteload Allocation, lbs**	**Delivery Factor**	**2013 Discharged Load, lbs**
HRSD James River Aggregate		**6,000,000**	**–**	**5,169,763**	**373,247**	**–**	**335,408**
Boat Harbor STP	20	740,000	1.0	925,895	53,239	1.0	26,671
James River STP	25	1,250,000	1.0	312,511	42,591	1.0	39,428
Williamsburg STP	22.5	800,000	1.0	241,899	47,915	1.0	33,924
Nansemond STP	30	750,000	1.0	283,001	63,887	1.0	82,696
Army Base STP	18	610,000	1.0	1,006,188	38,332	1.0	31,590
Virginia Initiative STP	40	750,000	1.0	798,691	85,183	1.0	69,656
Chesapeake-Elizabeth STP	24	1,100,000	1.0	1,601,578	51,110	1.0	51,443
2013 Delivered Nitrogen Exceedance/ (Credit) (lbs)				**-830,237**	**2013 Delivered Phosphorus Exceedance/ (Credit) (lbs)**		**-37,839**

Table 8-5 shows that for both nitrogen and phosphorus, the aggregate of the actual discharges from HRSD facilities to the James River was less than the “bubble” and therefore credits were generated. Individual facilities’ actual discharges varied in comparison to their individual wasteload allocations. For example, the Boat Harbor STP exceeded its individual nitrogen allocation and the James River STP was far below its nitrogen allocation. The HRSD aggregate James River nitrogen wasteload allocation was 6 million pounds and the actual 2013 discharge was 5.17 million pounds, which results in the generation of a 0.83 million pound credit. HRSD can make transfers within the “owner bubble” based on the actual performance of individual facilities. If credits are generated, the owner may pledge a percentage of credits to the Exchange. If loads exceed the bubble, credits must be purchased from the exchange to comply with the aggregate delivered wasteload allocation.

8.2.4.3 James River STP NPDES Permit

Table 8-6 presents a summary of the structure of the HRSD James River treatment plant effluent limits for phosphorus as an example. Table 8-6 shows the phosphorus and nitrogen concentration limits for the year. Section I.C.11 of the permit outlines the total nitrogen and total phosphorus nutrient reporting calculations. For each calendar month, the discharge monitoring report is to show the calendar year-to-date average concentration (mg/l) calculated as the average of the monthly average values reported through that month. For the calendar year, the discharge monitoring report for the following January is to report the calendar year average concentration calculated as the average of the monthly average values reported for the previous year.

Table 8-6. Hampton Roads Sanitation District (HRSD) James River STP NPDES Permit Limits for Phosphorus and Nitrogen.

Effluent Characteristics	Discharge Limitations		
	Monthly Average	Weekly Average	Maximum
Total Phosphorus Year-to-Date (mg/L)	NL	NA	NA
Total Phosphorus Calendar Year (mg/L)	2.0	NA	NA
Total Phosphorus (mg/L)	NL	NA	NA
Total Nitrogen Year-to-Date (mg/L)	NL	NA	NA
Total Nitrogen Calendar Year (mg/L)	12.0	NA	NA
Total Nitrogen (mg/L)	NL	NA	NA
NA = Not Applicable. NL = No limitation, however, reporting is required.			

8.2.5 Assabet River Watershed, Massachusetts

The Assabet River is an effluent-dominated stream in Massachusetts. During summer low flows, four major wastewater treatment facilities contribute 80% of the flow and 95% of the total phosphorus loading to the river. It was listed as nutrient-impaired in the 1990s, and the final TMDL was developed soon afterwards (Massachusetts DEP, 2004). The final effluent phosphorus limits for the four treatment facilities are in summarized in Table 8-7.

Table 8-7. Effluent Phosphorus Limits for Assabet River Dischargers (2004-2009).

Parameter	Units	Flow/Time Based Monitoring			
		Average Monthly Limit	Maximum Daily Limit	Sample Frequency	Sample Type
Phosphorus, Total (April)	lbs/day	Report	Report	3/Week	Daily Composite
Phosphorus, Total (April)	mg/L	0.1	0.2	3/Week	Daily Composite
Phosphorus, Total (May-October)	lbs/day	Report	Report	3/Week	Daily Composite
Phosphorus, Total (May-October)	mg/L	0.1	Report	3/Week	Daily Composite
Phosphorus, Total (November-March)	lbs/day	Report	Report	1/Week	Daily Composite
Phosphorus, Total (November-March)	mg/L	1.0	Report	1/Week	Daily Composite
Orthophosphorus, Dissolved (November-March)	lbs/day	Report	Report	1/Week	Daily Composite
Orthophosphorus, Dissolved (November-March)	mg/L	Report	Report	1/Week	Daily Composite

The April through October effluent phosphorus limits for each of the facilities includes interim limits of 0.75 mg/L and final limits of 0.10 mg/L:

"The permittee shall comply with the 0.1 mg/l TP limit in accordance with the schedule contained in Section F below. Upon the effective date of the permit, and until the date specified in Section F below for compliance with the total phosphorus final limit of 0.1 mg/l, an interim limit of 0.75 mg/l shall be met and monitoring shall be conducted twice per week."

The final summer phosphorus limit of 0.1 mg/L was reflected in the TMDL, but is based on EPA's 1986 Gold Book, not the outcome of the TMDL study. Massachusetts does not have numeric nutrient criteria for phosphorus. The TMDL states the following:

"The 1986 "Gold Book" criteria also provide guidance on this issue. The guidance states for phosphate phosphorus "To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphates as phosphorus (P) should not exceed 50 µg/l in any stream at the point where it enters any lake or reservoir, nor 25 µg/l within the lake or reservoir. A desired goal for the prevention of plant nuisances in streams or other flowing waters not discharging directly to lakes or impoundments is 100 µg/l TP". Thus, this guidance provides a range of acceptable criteria for phosphorus based upon specified conditions. It is with the spirit of this guidance that the TMDL for TP in the Assabet River has been developed."

A unique aspect of the Assabet River study is that each of the four wastewater facilities pursued their own wastewater treatment alternatives to achieve the final effluent limits. Each facility ended up selecting a different treatment approach, even though some of the same alternatives were evaluated by more than one facility. Selections were the result of various factors, including construction costs, solids handling costs, ease of operation, operations and maintenance costs, manufacturer's agreements, financial backing, re-use of existing facilities, life cycle costs, and flexibility (U.S. EPA, 2015). All four treatment facilities have been meeting the 0.1 mg/L summer effluent phosphorus limits as of 2012.

8.2.6 Las Vegas Wash and City of Las Vegas

The City of Las Vegas plant discharges into the Las Vegas Wash, which ultimately flows into Lake Mead and the Colorado River. Seasonal phosphorus and ammonia limits apply to the plant. The mass load allocation to the Las Vegas Wash is shared between three wastewater utilities: City of Las Vegas, Clark County Water Reclamation District, and the City of Henderson. TMDLs were developed for total ammonia as nitrogen and phosphorus in 1989. The dischargers were allocated individual wasteload allocations and a cumulative total loading, as shown in Table 8-8.

Table 8-8. Las Vegas Wash Wasteload Allocations for Phosphorus and Ammonia.

Constituent	City of Las Vegas IWLA	Clark County Sanitation District IWLA	City of Henderson IWLA	Sum of Waste Load Allocations ΣWLA
Total Phosphorus	**123 lb/day**	**173 lb/day**	**38 lb/day**	**334 lb/day** Note: This WLA only applies March 1 - October 31; no limit applies the rest of the year. Non-point source load is 100 lb/day.
Total Ammonia	**358 lb/day**	**502 lb/day**	**110 lb/day**	**970 lb/day** Note: This WLA only applies April 1 - September 30; no limit applies the rest of the year. No non-point source load.
IWLA = Individual Waste Load Allocation				

The associated NPDES permits include language which allows allocation trading between the dischargers. This permit condition constitutes a cooperative agreement between the utilities to allow discharge flexibility. Each facility has an Individual Waste Load Allocation (IWLA) and there is a Sum of Waste Load Allocations (∑WLA) defined below for all three of the facilities.

Table 8-9 illustrates the structure of the City of Las Vegas NPDES permit with the linkage to the shared wasteload allocation. Provisions of the permit specify accounting for the phosphorus and ammonia loadings and reporting requirements. Compliance is achieved by not exceeding the individual allocations, or the individual loading adjusted by transfers, or by not exceeding the cumulative total of the allocations.

Table 8-9. City of Las Vegas NPDES Permit Structure for Phosphorus and Ammonia.

Parameters	Effluent Discharge Limitations or Reporting Requirements		
	30 Day Average	7 Day Average	30 Day Average lb/day
Total Phosphorus	Wasteload Allocation		
Ammonia	Wasteload Allocation		

Annually, the dischargers may modify their individual allocations by transferring or receiving loadings from another discharger. The annual re-allocation must be documented and signed by all three dischargers and is to be submitted to the state by May 31st. The notification is required to include the flow, waste load discharged, and treatment plant removal efficiency. An annual re-allocation is considered a minor modification to the permit as long as the cumulative total load allocation is not changed.

Temporary trading of loadings is allowed and is again required to be documented in writing and signed by all three dischargers. The documentation must include the amount of the individual load allocation transferred, the length of time the transfer is effective, and the basis for the transfer to identify the last monthly flows and waste load discharged for each discharger. Transfers are binding on the parties and cannot be revoked without a notification signed by all three dischargers. The transferred load reverts back to the original permittee at the end of the specified time.

8.2.7 San Francisco Bay, California

The San Francisco Bay estuary has long been known to be nutrient-enriched. Despite this, the abundance of phytoplankton in the estuary is lower than would be expected due to a number of factors, including strong tidal mixing; high turbidity, which limits light penetration; and high filtration by clams. The estuary ecosystem is quite complex, with food web components being influenced by both anthropogenic and natural drivers over decadal time scales (Cloern and Jassby, 2012). While nutrient discharges to the San Francisco Bay have not yet resulted in impairment problems (e.g., excessive algal growth), recent studies have shown that the Bay's historic resilience to nutrient loading may be weakening. As a result, nutrients are a growing concern for the health of the ecosystem.

Since 2006, the California State Water Resources Control Board (SWRCB) and the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) have been facilitating development of Nutrient Numeric Endpoints (NNEs) for the Bay. Additional activities include examination of nutrient management strategies (SFRWQCB, 2012) and development of a nutrient assessment framework (SFRWQCB, 2013).

The Bay Area Clean Water Agencies (BACWA) is a joint powers agency formed under the California Government Code by the five largest wastewater treatment agencies in the San Francisco Bay Area (BACWA, 2014). The BACWA, SFRWQCB, and the San Francisco Estuary Institute (SFEI) have had a strong working relationship for many years. One of the initial efforts was to better understand the nutrient loadings to the Bay. SFEI compiled data which found municipal wastewater treatment plants represent about 63% of the annual nitrogen load to the Bay (SFEI, 2013). About 90% of the annual nitrogen load from municipal wastewater treatment plants is from facilities that have a permitted design flow of 10 mgd or greater.

In 2012, BACWA requested a nutrient watershed permit concept evaluation (Grovhoug et al., 2012a). The evaluation considered seven different regulatory approaches and five different overarching frameworks, along with several evaluation criteria. It was concluded that there were three best apparent alternatives for the regulatory approach to nutrient management (individual NPDES permits, nutrient watershed permit, and narrative objective implementation) and two for the overarching framework (Basin Plan Amendment and Memorandum of Agreement/ Memorandum of Understanding (MOA/MOU)). A follow-up evaluation (Grovhoug et al., 2012b) examined implementation of a narrative objective implemented in a nutrient watershed permit (i.e., regulatory approach) with an MOA/MOU and subsequent basin plan amendment (i.e., overarching framework).

8.2.7.1 San Francisco Nutrient Watershed Permit

BACWA then approached the SFRWQCB with a proposal for a nutrient watershed permit. Many ideas were exchanged between BACWA and the SFRWQCB regarding the content of the NPDES permit, with little involvement from the EPA. The nutrient watershed permit was signed in April 2014 (SFRWQCB, 2014) with an effective date of July 1, 2014, and an expiration date of June 30, 2019. Thirty-seven dischargers with cumulative permitted discharge capacity nearing 860 mgd are participating in this permit. The design flows and existing nutrient loadings from the five largest dischargers who are the Principal Members of BACWA out of the total group of 37 dischargers are summarized in Table 8-10.

Table 8-10. Design Flows and Existing Nutrient Loadings from Principal Members of BACWA.

Discharger	Design Flow, mgd	Average Annual Load, kg/day	
		Total Nitrogen	**Total Phosphorus**
San Jose/Santa Clara WPCP	167	5,233	332
City and County of San Francisco (Southeast Plant)	150	8,307	101
East Bay Municipal Utility District (EBMUD)	120	10,583	973
East Bay Dischargers Authority (EBDA)	107.8	8,641	555
Central Contra Costa Sanitary District (CCCSD)	53.8	4,187	138

Special provisions of the nutrient watershed permit require that each facility conduct or support the following three main areas to address nutrient reduction and receiving water quality:

1. **Evaluation of Potential Nutrient Discharge Reduction by Treatment Optimization and Side-Stream Treatment**. This evaluation focuses on options and costs for nutrient discharge reduction by optimization of current treatment works and side-stream treatment opportunities.

   - Describe the treatment plant, treatment plant process, and service area.
   - Evaluate site-specific alternatives, along with associated nitrogen and phosphorus removal levels, to reduce nutrient discharges through methods such as operational adjustments to existing treatment systems, process changes, or minor upgrades.
   - Evaluate side-stream treatment opportunities along with associated nitrogen and phosphorus removal levels.
   - Describe where optimization, minor upgrades, and sidestream treatment have already been implemented.
   - Evaluate beneficial and adverse ancillary impacts associated with each optimization proposal, such as changes in the treatment plant's energy usage, greenhouse gas emissions, or sludge and biosolids treatment or disposal.
   - Identify planning level costs of each option evaluated.
   - Evaluate the impact on nutrient loads due to treatment plant optimization implemented in response to other regulations or requirements.

2. **Evaluation of Potential Nutrient Discharge Reduction by Treatment Upgrades or Other Means**. This evaluation focuses on identification of options and costs for potential treatment upgrades for nutrient removal.

   - Identify potential upgrade technologies for each treatment plant category along with associated nitrogen and phosphorous removal levels.
   - Identify site-specific constraints or circumstances that may cause implementation challenges or eliminate any specific technologies from consideration.
   - Include planning level capital and operating cost estimates associated with the upgrades and for different levels of nutrient reduction, applying correction factors associated with site-specific challenges and constraints.
   - Describe where Dischargers have already upgraded existing treatment systems or implemented pilot studies for nutrient removal. As part of this description, document the level of nutrient removal the upgrade or pilot study is achieving for total nitrogen and phosphorus.
   - Evaluate the impact on nutrient loads due to treatment plant upgrades implemented in response to other regulations and requirements.
   - Evaluate beneficial and adverse ancillary impacts associated with each upgrade, such as changes in the treatment plant's energy use, changes in greenhouse gas emissions, changes in sludge and biosolids treatment or disposal, and reduction of other pollutants (e.g., pharmaceuticals) through advanced treatment.

Nutrient removal by other means includes evaluation of ways to reduce nutrient loading through alternative discharge scenarios, such as water recycling or use of wetlands, in combination with, or in-lieu of, the treatment plant upgrades to achieve similar levels of nutrient load reductions.

- Reduction in potable water use through enhanced reclamation.
- Creation of additional wetland or upland habitat.
- Changes in energy use, greenhouse gas emissions, sludge and biosolids quality and quantities.
- Reduction of other pollutant discharges.
- Impacts to existing permit requirements related to alternative discharge scenarios.
- Implications related to discharge of brine or other side-streams associated with advanced recycling technologies.

3. **Monitoring, Modeling, and Embayment Studies**. This provision focuses on science plan development and implementation, as well as monitoring nutrients in receiving waters.
    - Support the science plan development and implementation.
    - Support receiving water monitoring for nutrients.

The NPDES permit allows the wastewater facilities to perform the permit tasks collectively as a group, or individually. All 37 participating facilities decided to perform the efforts collectively as a group. The first two tasks are being performed by a consulting firm team, whereby a report for each facility will be produced to address these task requirements for nutrient removal optimization and upgrade.

The third task, supporting the science plan is an on-going effort led by SFEI. The key elements that comprise the science plan are as follows[1]:

1. Monitoring special studies (e.g., algal toxin pigment studies).
2. Modeling of San Francisco Bay.
3. Loads analysis (e.g., moored sensors data).
4. Developing a water quality assessment framework.
   The emphasis is to integrate across the plans to develop an overarching nutrient strategy framework for San Francisco Bay.

The permit reporting and compliance schedule extends from 2014 to 2019, with 5-year renewals beyond that time. There are a number of specific calendar date schedule requirements for submittals and implementation, summarized as follows:

- By December 1, 2014, dischargers were required to submit and implement a Scoping Plan that defines the level of work for the treatment process optimization evaluation.
- By July 1, 2015, dischargers are required to submit an Evaluation Plan that includes a schedule describing how they will conduct the evaluation of potential nutrient discharge

[1] http://sfbaynutrients.sfei.org/books/nms-steering-committee-meeting-materials

reduction by treatment optimization. The evaluation Plan is required to include sampling, as necessary, to support proposed optimization studies.

- Dischargers are required to proceed with implementation of the Evaluation Plan within 45 days of submittal.
- By July 1, 2016 and July 1, 2017, dischargers are to submit Status Reports describing the tasks completed, preliminary findings, and tasks to be completed, highlighting any adaptive changes to be made to the Evaluation Plan.
- By July 1, 2018 dischargers are required to submit a Final Report on the results of evaluations with planning level cost estimates for each optimization option studied and for each upgrade option studied.

CHAPTER 9.0

SPECIAL TOPICS IN NUTRIENT PERMITTING

This chapter presents a group of special topics which have an influence on nutrient discharge permitting. The topics include the bioavailability of nitrogen and phosphorus, nutrient offsets and water quality trading, filtered and unfiltered effluent, anti-degradation, and anti-backsliding. Each of these topics may be important considerations in nutrient discharge permitting and may influence the structure of NPDES permits and effluent limits. These subjects are likely to require an additional effort beyond simple NPDES permit renewals in order to include their potential benefits in discharge permitting. That may require an investment in monitoring and analytical work, watershed analysis and modeling to quantify loadings and simulate nutrient processing, and policy development and regulatory negotiations in order to receive full consideration in permitting.

9.1 Bioavailability

Understanding changes in nutrient speciation and bioavailability that occur in advanced nutrient removal treatment is important because effluent concentrations are not only reduced, but the nature of the remaining nitrogen and phosphorus that is discharged is fundamentally changed. Effluent concentrations are reduced, nutrient speciation is altered, and the bioavailability of the remaining nutrients is reduced because the most advanced biological nutrient removal processes will remove most, if not all, of the bioavailable species. This is important to understand for discharge permitting, as well as watershed management, because the nutrients that remain in the effluent from advanced treatment facilities will not impact receiving waters in the same way as secondary effluent.

Understanding changes in nutrient speciation that occur in advanced treatment is recognition that the percentages and mass of nutrients characterized by different degradation rates in receiving water modeling also changes. The term “bioavailable” is used in this discussion, although this terminology is evolving and “slowly bioavailable” may better characterize the soluble nonreactive nitrogen and phosphorus fractions remaining in advanced nutrient removal treatment. Terminology aside, bioavailable means readily available for uptake.

Research and monitoring data have shown that as treatment facilities remove nutrients to lower concentrations, especially at the limits of treatment technology, the remaining nutrients in the effluent discharged to the receiving water are generally classified as slowly bioavailable. Further reducing the slowly bioavailable nutrients remaining in the effluent may not provide significant benefits to the water quality of the receiving water. The high cost of treatment and the lack of potential benefit to the receiving water make nitrogen and phosphorus speciation an important area of nutrient research, both in terms of biodegradability in wastewater treatment and bioavailability in the water environment.

WE&RF research has investigated nitrogen and phosphorus speciation in terms of biodegradability in wastewater treatment and bioavailability in the water environment (Sedlak, 2013) (Li and Brett, 2011, 2012, 2013a, 2013b, 2014). Bioavailability is a broad term that captures the ability of bacteria, algae, and other organisms to use nitrogen and phosphorus to support growth under natural conditions (temperature, salinity, sunlight exposure, biological, and long time periods) (WERF, 2014). Simple inorganic nutrient molecules (ammonia, nitrate, nitrite, and phosphate) are readily available to support algal growth in natural water. However, the bioavailability of soluble complex molecules is less certain and research efforts continue because of the importance to both the design and economics of wastewater treatment and the implications for watershed management.

Research into advanced levels of nutrient removal treatment is revealing new information about N and P speciation and reduced bioavailability of the nitrogen and phosphorus remaining after advanced treatment. Water quality modeling of future watershed scenarios should reflect changes in N and P speciation and bioavailability based on the most contemporary information available from this research (WERF, 2014). Modeling, performed by regulatory agencies and others, commonly assumes that refractory compounds are readily bioavailable and as a result, may reach inaccurate conclusions about a waterbody's response to nutrient loadings following advanced levels of nutrient removal treatment. That could result in more restrictive discharge permit limitations than necessary and may misrepresent the relative magnitudes of point sources and nonpoint sources in ways that may mislead watershed management efforts (WERF, 2014).

The translation of TMDL wasteload allocations to NDPES permits limits can vary significantly depending upon the characterization of nutrients in the effluent and how the effluent is represented in water quality modeling. The more sophisticated water quality models have the capability, as currently structured, to accept input describing nutrient speciation and bioavailability providing that monitoring data is available to accurately characterize effluent and receiving waters. Much is known about effluent speciation following advanced nutrient removal treatment as described in Chapter 5.0. This information can be used in water quality modeling and discharge permitting. There are a limited number of cases where nutrient bioavailability has been considered for in NPDES permitting. Onondaga County in New York and the Spokane County permit in Washington are examples.

9.1.1 Onondaga County

The Onondaga County (New York) Department of Water Environment Protection Metropolitan Syracuse Wastewater Treatment Plant (Metro) discharges tertiary effluent to Onondaga Lake. Metro serves a combined sewer system and has a State Pollutant Discharge Elimination System (SPDES) permit to discharge up to 126.3 mgd via two outfalls. Flows receive tertiary treatment for year round for nitrification and P removal and UV disinfection and are discharged through Outfall 001. Flows above 126.3 mgd up to 240 mgd receive primary treatment and disinfection and are discharged through Outfall 002.

Onondaga Lake was listed as impaired on New York's 1996 303(d) list due to excessive P loadings to the lake. Metro's SPDES permit contains stringent TP limits based on a 1998 Phase 1 TMDL for TP to Onondaga Lake that primarily addressed loadings from Metro. Significant treatment upgrades have been made, including installation of a biological aerated filter (BAF) system which came online in January of 2004 and enables the facility to provide year-round nitrification. A high rate flocculated settling (HRFS) system (Actiflo) brought online in 2005 uses coagulation, flocculation, and sedimentation processes to convert soluble phosphorus to a particulate form which is readily removed.

Characterization of the nutrients from the Onondaga County wastewater treatment plant has been partially completed. Upstate Freshwater Institute and the Department of Civil and Environmental Engineering at Michigan Technological University (Anchor-QEA, 2010) determined through bioavailability assays that only 1% of the particulate phosphorus in the effluent is bioavailable and that the total concentration of bioavailable forms of phosphorus only account for approximately 30 ug/L, or approximately 6,000 lb/year at current average flows (NYSDEC, 2012). The bioavailability findings were considered as part of the model scenarios.

9.1.1.1 Onondaga County Permit

The Onondaga County SPDES Permit No. NY 002 7081 that was issued by the New York State Department of Environmental Conservation (NYSDEC), has an effective date of March 21, 2012, and expires on March 20, 2017. The current SPDES permit includes12-month rolling average limits for both flow (84.2 mgd) and TP for Outfall 001, as summarized in Table 9-1. The current permit requires monitoring for P, but does not set P limits, for Outfall 002.

Table 9-1. Onondaga County Effluent Phosphorus Limits.

<table>
<tr><th colspan="2" rowspan="2">Parameter</th><th colspan="2">Effluent Limit</th></tr>
<tr><th>Type</th><th>Limit</th></tr>
<tr><td colspan="2" rowspan="2">Total Phosphorus</td><td>30-day Arithmetic Mean</td><td>Monitor mg/L</td></tr>
<tr><td>12-month Rolling Average</td><td>0.02 mg/L</td></tr>
<tr><td>Footnote 2</td><td colspan="3">The 12-month rolling average shall be the average of the monthly average of the current month plus the monthly averages of the eleven previous months</td></tr>
<tr><td rowspan="5">Footnote 5</td><td colspan="2">Effective Dates</td><td>Phosphorus Limit
(12-month rolling average)</td></tr>
<tr><td colspan="2">May 1, 2004 to March 31, 2006</td><td>Interim Limit = 400 lb/day</td></tr>
<tr><td colspan="2">April 1, 2006 to November 15, 2010</td><td>Interim Limit = 0.12 mg/L</td></tr>
<tr><td colspan="2">November 16, 2010 to December 31, 2015</td><td>Interim Limit = 0.10 mg/L</td></tr>
<tr><td colspan="2">After December 31, 2015</td><td>Final Limit = 0.02 mg/L</td></tr>
</table>

Interim TP limits based on a 12-month rolling average are included in the permit. From May 2004 through March 2006, the limit was 400 lb/day. From April 2006 through November 15, 2010, the limit was 0.12 mg/L. November 16, 2010, through December 2015 the limit is 0.10 mg/L. Beginning January 2016, the final limit is 0.02 mg/L.

Permit provisions allow the TP limits to be revised based on subsequent TP TMDLs and allocations. In May 2012, the NYSDEC issued a comprehensive TP TMDL for Onondaga Lake. For Metro, the 2012 TMDL calls for maintaining the final TP limit for Outfall 001 at 0.1 mg/L and adding a bubble annual mass loading limit of 27,212 lb/year for Outfalls 001 and 002 combined, both on a 12-month rolling average basis. Onondaga County is pursuing modifications to the Metro SPDES permit to incorporate the effluent TP limits proposed in the 2012 TMDL.

9.1.2 Spokane County

Spokane County Division of Utilities located in eastern Washington in Spokane, WA, was issued a permit for a new reclamation facility to discharge to the Spokane River. As part of the Spokane River dissolved oxygen TMDL process, a phosphorus bioavailability study was conducted by the University of Washington using an algal growth bioassay methodology (Li and Brett, 2011). Samples were gathered from advanced phosphorus removal pilot facilities in the City of Spokane, along with effluent from treatment plants at the City of Coeur d’Alene, City of Post Falls, Liberty Lake Water and Sewer District, Hayden Area Regional Sewer Board, Inland Empire Paper, and surface water samples from the Spokane River. The treatment facilities discharging to the Spokane River employ chemical precipitation for seasonal phosphorus removal targeting effluent less than 1 mg/L, or 85% removal at the time the TMDL was being formulated. The advanced treatment pilot facilities were focused on very low effluent concentrations less than 0.05 mg/L total phosphorus. This study found that the advanced treatment processes in the City of Spokane pilot plant reduced total phosphorus from approximately 3 mg/L in the influent to the pilot processes to approximately 0.019 mg/L in the final effluent from advanced treatment processes. The bioassays showed that the bioavailable phosphorus decreased sharply from an average of 79% to an average of 7%.

This study also explored whether more conventional and easily carried out measures of phosphorus composition could be used in place of algal bioassays to quantify bioavailable phosphorus (BAP) of wastewater effluent. The results showed that the final BAP of the effluent was only about 50 percent of the "reactive" phosphorus concentration when looking at all of the advanced phosphorus removal processes in the City of Spokane pilot study. This suggests it might be possible to use TRP as a conservative measure of BAP.

WERF sponsored a second phase of phosphorus bioavailability studies by the University of Washington using the algal bioassay methodology to address the interest in further investigations of phosphorus bioavailability from a broader variety of advanced treatment processes and receiving waters (Li and Brett, 2014). The Washington Department of Ecology and EPA also suggested several phosphorus bioavailability related topics that warranted follow-up research. In the Phase II study, bioassays were used to determine the mineralization rate of soluble phosphorus in effluents from a broad range of advanced nutrient removal technologies, including traditional advanced biological treatment processes, membrane bioreactor (MBR), tertiary membrane filtration, and dual stage Blue PROTM filtration. Wastewater specific soluble phosphorus mineralization first-order rate kinetics were defined that could be used in water quality modeling (Li and Brett, 2014). Mineralization rates from analytical studies could be integrated into the current Spokane River CE-QUAL-W2 model without modifications to the model. Soluble phosphorus mineralization rates determined for the BOD degradation rates could be used to replace the decay rates in the current water quality model.

9.1.2.1 Spokane County Permit

The Washington Department of Ecology issued Spokane County a permit (WA-0093317) on November 29, 2011, which expires on November 31, 2016. Effluent limits were based upon a dissolved oxygen TMDL for the Spokane River and Lake Spokane, with requirements to reduce CBOD, NH_3-N, and TP. Final effluent limits are summarized in Table 9-2 and include a seasonal mass TP loading based on a 2.80 lb/day average over the March through October season. For NH_3-N, maximum daily final concentration limits for March through May and October are 16 mg/L, while June through September are 8 mg/L. For March through May and October, final average monthly NH_3-N load limits are 55.4 lb/day. For June through September, NH_3-N load limits are 14.0 lb/day.

The Spokane County permit does not currently account for phosphorus bioavailability but includes provision for future considerations depending upon the results of further bioavailability studies. The effluent limits tables in the permit include a footnote based on discussions with the Department of Ecology in the course of the development of the TMDL and the phosphorus bioavailability studies, as follows:

- Footnote g: “Future adjustments to the final effluent limitation based on demonstrated pollutant equivalencies or non-bioavailable P will be implemented as major permit modifications requiring public notice and comment.”

Table 9-2. Spokane County NPDES Permit (WA-0093317) Key Effluent Limits and Footnotes.

Effluent Limits: Outfall #001		
Parameter	**Seasonal Limit Applies March 1 to October 31 See notes f and g**	
Cabonaceous Biochemical Oxygen Demand (5-day)(CBOD5)	280 pounds/day (lbs/day)	
Total Phosphorus (as P) March 1 to Oct. 31	2.80 lbs/day	
Total Ammonia (as NH3-N)	**Seasonal Limit**	**Maximum Daily Limit**
For “season” of March 1 to March 31	1067.5 lbs/day average	16 mg/L
For “season” of April 1 to May 31	66.7 lbs/day average	16 mg/L
For “season” of June 1 to Sept. 30	16.7 lbs/day average	8.0 mg/L
For “season” of Oct. 1 to Oct. 31	66.7 lbs/day average	16 mg/L
Parameter	**Average Monthly**	**Average Weekly**
Carbonaceous Biochemical Oxygen Demand (5-day) (CBOD5), November 1 through February 29	2.0 milligrams/liter (mg/L) 133 pounds/day (lbs/day)	—
Select Footnotes		
f	Compliance with the effluent limitations for CBOD5, NH3-N, and TP will be based on: 1) a seasonal average with the running seasonal average for the season reported monthly for tracking compliance with the allowable mass limitation, and 2) a combination of reported effluent quality, pollutant equivalencies in term of oxygen depletion and pollutant credits earned from Septic Tank Eliminations and approved by Washington DOE, following a revised run of the current, 2011, CE-QUAL-W2 model demonstrating compliance with DO TMDL wasteload allocation and permit conditions. The model run results and accompanying documentation will be submitted to the DO TMDL advisory committee for review and to Washington DOE for review, comment (if needed) and Washington DOE approval.	
g	Future adjustments to the final effluent limitations based on demonstrated pollutant equivalencies or non-bioavailable P will be implemented as major permit modifications requiring public notice and comment.	

9.2 Water Quality Trading and Offsets

Water quality trading is an innovative approach to achieve water quality goals more efficiently. Trading is based on the fact that sources in a watershed can face very different costs to control the same pollutant. Trading programs allow dischargers facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost.

The basis of trading is that a water quality goal is established and that sources within the watershed have significantly different costs to achieve comparable levels of pollution control.

Water quality trading is a voluntary option that regulated point sources can use to meet their NPDES permit limits. Where watershed circumstances favor trading, it can be a powerful tool for achieving pollutant reductions faster and at a lower cost. Water quality trading will not work everywhere, however, and works best when:

- A "driver" motivates facilities to seek pollutant reductions, usually a TMDL or a more stringent water quality-based requirement in an NPDES permit.
- Sources within the watershed have significantly different costs to control the pollutant of concern.

- The necessary levels of pollutant reduction are not so large that all sources in the watershed must reduce as much as possible to achieve the total reduction needed – in this case there may not be enough surplus reductions to sell or purchase.
- Watershed stakeholders and the state regulatory agency are willing to try an innovative approach and engage in trading design and implementation issues.

The purpose of this section is to provide information regarding EPA and state policy specifically related to nutrient trading programs as they pertain to NPDES nutrient permitting, with case studies highlighting successes and challenges.

9.2.1 EPA Policy

In January 2003, the EPA issued the *National Water Quality Trading Policy*, supporting trading as an innovative and market-based approach to improving water quality (U.S. EPA, 2003c). The policy states that trading should occur in a geographical area where a TMDL for either nutrients or sediments has been approved by EPA. The policy also defines when trading may occur (e.g., pre-TMDL period), alignment with the CWA, EPA's oversight role, and common elements that should be in a trading program.

The EPA issued the *Water Quality Trading Assessment Handbook* in 2004, which provides guidance on how stakeholders can environmentally and economically determine whether trading is feasible in their watershed (U.S. EPA, 2004b). The handbook provides a framework to assess the conditions and water quality problems in a given watershed to determine whether trading could be effectively used.

The EPA's 2007 publication *The Water Quality Trading Toolkit for Permit Writers* is the first "how-to" manual on designing and implementing water quality trading programs. The Toolkit helps NPDES permitting authorities incorporate trading provisions into permits (U.S. EPA, 2007b). The document emphasizes that to be implementable and enforceable under the CWA, trading provisions involving permitted point sources should be incorporated into NPDES permits. Scenarios are given to guide the permit writer pertaining to the following:

- Single Point Source to Single Point Source Trading.
- Multiple Facility Point Source Trading.
- Point Source Credit Exchanges.
- Point Source to Non-Point Source Trading.
- Non-Point Source Credit Exchanges.

9.2.2 Potential Issues

Nutrients originating from point sources can be quantified with a high degree of assurance because the discharge points are well defined (usually a pipe) and monitored. Therefore nutrient loads can be defined quite accurately, providing confidence when conducting water quality trading between point source dischargers.

Point source to non-point source trades, however, may be more complex. Two factors illustrate the complexities. First, EPA calls for trading ratios to be applied to point source to nonpoint source trades. Second, EPA's trading policy requires that when a TMDL exists, non-point source reductions to offset point sources must be in excess of the load allocations required of the non-point sources.

Application of trading ratios may diminish the potential for point source to non-point source trades to be attractive because they increase the nonpoint source load reduction required to offset a point source. The EPA Water Quality Trading Toolkit for Permit Writers identifies that "the basic categories of trading ratios are delivery, location, equivalency, retirement, and uncertainty." (U.S. EPA, 2007b). The uncertainties about nonpoint source reductions include lack of knowledge about how effective nonpoint source controls will be, the time lag between implementation and full performance, the location of the nonpoint source controls with respect to point sources, and uncertainty about when reductions will be achieved. Since there is uncertainty in determining the degree to which non-point source BMPs reduce nutrient loads, regulatory agencies look for reasonable assurance that the non-point source reductions will actually attain their predicted effectiveness. So if a point source discharger needs to offset a pound of phosphorus, a non-point source reduction of 1.5 pounds of P may be required (i.e., a 1.5X trading ratio).

9.2.2.1 Satisfying Nonpoint Source Load Allocations in TMDLs

The state of Montana developed a policy on nutrient trading in conjunction with numeric nutrient criteria rulemaking (MT DEQ, 2012). Trades are allowed between point sources, between point and non-point sources, as well as between non-point sources. Trading may be used to:

1) *Comply with an approved TMDL for nutrients.*
2) *Offset a new or increased discharge of nutrients.*
3) *Comply with water quality-based effluent limits for nutrients.*
4) *Offset a new or increased discharge of nutrients into "high quality" waters.*

Montana DEQ provided EPA Region 8 with a draft of the nutrient trading policy in 2010. In response, EPA (2011) identified the need for nonpoint source reductions to be beyond the load allocation in a TMDL to qualify as an allowable trading credit to offset a point source load:

"From our discussions with the State, it is EPA's understanding that DEQ interprets this language to mean that nonpoint sources can generate credits as soon as they begin to reduce their nutrient load. DEQ considers these credits to be available for purchase by point sources assigned a WLA in a TMDL. Because TMDL load allocations (LAs) are not part of DEQ's nonpoint source baseline, the proposed trading policy would allow for generation of trading credits before a nonpoint source LA has been met. While EPA understands and agrees with DEQ's position that any nutrient reduction benefits the environment, we differ on what constitutes an allowable trading credit.

EPA's trading policy states that, where a TMDL is in place, the LA serves as the baseline for nonpoint sources to generate credits. Generating trading credits before a nonpoint source LA has been met is problematic because of the relationship between TMDLs and the permitting process. Federal and state law requires DEQ to establish TMDLs for water quality-impaired segments "at levels necessary to attain and maintain the applicable narrative and numerical WQS." 40 C.F.R. § 130.7(c)(1), MCA 75-5-703(1). A TMDL consists of "the sum of individual WLAs for point sources and LAs for nonpoint sources and natural background." 40 C.F.R. § 130.2(i), MCA 75-5-103(37). When developing a TMDL, DEQ establishes the WLAs and LAs in a TMDL by calculating the greatest amount of loading that the impaired water can receive without violating the applicable water quality standard and allocating this "loading capacity" between point sources and nonpoint sources. 40 C.F.R. § 130.2(f), MCA 75-5-103(18). Any *loading from point sources and nonpoint sources that exceeds the total loading capacity in a TMDL will result in an exceedance of the applicable water quality standard."*

The problem that this creates is that nutrient TMDLs often result in load allocations that exceed the capabilities of BMPs to accomplish nonpoint load reductions. In that case, there is little chance of any excess nonpoint source reductions being created to offset point source loads. This circumstance may considerably diminish the interest in water quality trading.

9.3 State Trading Policies and Key Watersheds

Water quality trading at the state and watershed level has expanded in the last decade (e.g., ETN, 2014). The following select case studies illustrate how nutrient trading has developed and influenced NPDES discharge permitting.

9.3.1 Long Island Sound and Connecticut Trading Program

Low dissolved oxygen levels in Long Island Sound have been attributed to excess nitrogen originating from New York and Connecticut, resulting in a TN TMDL. In Connecticut, a nitrogen general NPDES permit and a Nitrogen Credit Exchange Program were developed in 2002. The general permit for nitrogen discharges only addresses total nitrogen discharges from 79 municipal facilities and sets nitrogen limits for each facility (e.g., Connecticut DEEP, 2013) that are based on the 2002 TMDL wasteload allocations. The general permit sets 2015 nitrogen discharge goals for each of the 79 municipal facilities that match their respective wasteload allocation in the 2002 TMDL document. The exchange program was developed to allow purchase of credits for municipal facilities that have difficulty meeting their nitrogen limits.

Based on the success of Connecticut's point source to point source trading program, recent efforts have been made to investigate expanding nutrient trading to include non-point sources, as well as including New York nitrogen contributions to Long Island Sound (e.g., Haimann and Rangarajan, 2012). The report suggests that a 10% reduction in non-point source nitrogen loads may be possible, but challenges to inclusion of non-point sources in a trading program include estimation of nitrogen control costs, the potential for excessive monitoring requirements, and the administrative/technical burden associated with increased monitoring.

Key factors to consider in the development a nutrient trading program that were important in Connecticut include loading sources (point source v. nonpoint sources), wealth differences across the region (urban v. rural), and implementation of a stakeholder program from the outset. Success of the Connecticut nitrogen trading program has been attributed in part to early and frequent communication with stakeholders (Johnson, 2015). An important activity to support the development of the program was the conduct of many workshops across the state to explain the benefits of participating in a water quality trading program. This included efforts by the Connecticut DEEP to convey the merits of such a program to EPA Region 1.

Creating trust with stakeholders was crucial in the development of the nitrogen trading program. Connecticut is a highly urbanized state, with most nitrogen loading coming from point source dischargers, as opposed to nonpoint sources such as agriculture. The more rural areas in northern part of the state had fewer financial resources compared to the southeast part of the state. The larger cities recognized that they were the largest contributors to nitrogen loadings to Long Island Sound and supported the trading program. Other stakeholders were influenced by the potential cost to small communities to upgrade their wastewater facilities to meet low nitrogen effluent discharge requirements if they opted for an individual NPDES permit. A small community could face multi-million dollar capital financing requirement to upgrade wastewater facilities, in comparison to a smaller investment on an annual basis to purchase nitrogen credits.

Another factor in the success of the Connecticut nitrogen trading program is that the state agree to buy or sell any credits at the end of the year. The nitrogen reduction goals for Long Island Sound have been met, but smaller facilities in more rural areas still rely on the purchase of credits to meet their nitrogen discharge requirements. One notable change to the program is that beginning in 2015, the state is not required to subsidize the program. The ramifications of this policy change are not yet clear.

9.3.2 Virginia Nutrient Credit Exchange Association

The Virginia DEQ has developed strategies for each of its tributaries entering Chesapeake Bay, assigning nutrient load allocation to both point and nonpoint sources. A watershed-based NPDES general permit was developed to encompass 125 dischargers in 2006 (U.S. EPA, 2007a; Virginia DEQ, 2014a), as well as a nutrient trading program. The second general permit is in effect for the period January 1, 2012, to December 31, 2016. All point sources covered by nitrogen and phosphorus WLAs set originally in Virginia's tributary strategies dating back to 2005 and now included in the Chesapeake Bay TMDL (U.S. EPA, 2010a) must register for coverage under the general permit.

Dischargers have two basic options for compliance, either directly meet their annual wasteload allocation for nitrogen and phosphorus in their discharge, or obtain N and P credits to offset nitrogen and phosphorus loads exceeding their wasteload allocations. Effluent limits in the permit are set as annual wasteload allocations in lbs/yr TN and TP. Concentration limits typically are included in individual VPDES permits when the facility has received state Water Quality Improvement fund grants or revolving loan funds to construct nutrient removal upgrades. The concentration limits are set as annual average concentration (mg/l) limits and are technology-based (based on the process upgrade is designed to achieve). The technology-based concentration limits are used to ensure that the facility is operating the nutrient removal process as intended and ensure that wastewater flows are below their design criteria in order to generate nutrient credits for trading.

The Virginia Nutrient Credit Exchange Association was formed at about the same time as the first general permit was issued and serves as the clearinghouse for nutrient trades among the members. The Exchange also provides compliance reporting on behalf of its members, as specifically authorized in the general permit (VNCEA, 2014). While initial efforts were focused on constructing many nutrient removal technology upgrades at member facilities to achieve compliance with Chesapeake Bay wasteload allocations, efforts now are concentrated on maintaining compliance through additional facility upgrades. Member facilities who reduce nutrient loads beyond their specified wasteload allocation requirement (i.e., generate expected net credits) may sell credits to member facilities who fall short of meeting their regulatory wasteload allocation. New participants in the exchange may be considered.

Annual nutrient load analysis is required by state law. The 2013 annual nutrient load analysis (Virginia DEQ, 2014a) reported nitrogen and phosphorus loads from permitted facilities throughout the state. Adequate credits were available in each of the state's five major basins. All but 20 facilities met their wasteload allocations and each of those was required to purchase credits from the nutrient exchange (Virginia DEQ, 2014b).

A recent example of a major discharger's draft VPDES permit is the Lexington-Rockbridge Regional Water Quality Control Facility in Lexington, VA (City of Lexington, 2014a, 2014b). Nutrient calculations for nitrogen and phosphorus are based on the state general permit (Virginia DEQ, 2014a). For nitrogen and phosphorus concentrations below the quantification level for the analytical method, concentrations are to be reported as half of the quantification level. This facility has a design average flow of 3.0 mgd, and a permitted annual average total phosphorus discharge of 0.5 mg/L and total nitrogen discharge of 6.0 mg/L. The facility requested effluent limitations for a proposed expansion to a design average flow of 6.0 mgd, which would be subject to a permitted annual average total phosphorus discharge of 0.25 mg/L and total nitrogen discharge of 3.0 mg/L. The facility was in compliance for phosphorus and nitrogen in 2013.

The basis for these Lexington-Rockbridge WWTP limits are from GM No. 07-2008 (Amendment No. 2, 10/23/07, Permitting Considerations for Facilities in the Chesapeake Bay Watershed). Annual average concentration limits are based on the Technology Regulation (9VAC25-40). In addition to any nutrient concentration limits, the facility has nitrogen and phosphorus calendar year load limits associated with Outfall 001 included in the current Registration List under registration number VAN040068, enforceable under the General VPDES Watershed Permit Regulation for TN and TP Discharges and Nutrient Trading in the Chesapeake Watershed in Virginia.

The Lexington-Rockbridge WWTP is covered under the General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for TN and TP Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia (9VAC25-820). The effective date of coverage is January 1, 2012. Coverage under the general permit will expire December 31, 2016. The load limit for TN is 54,820 lbs/year (the product of 3.0 mgd and 6.0 mg TN/L) and TP is 4,568 lbs/year (the product of 3.0 mgd and 0.5 mg TP/L). The Regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed (9VAC25-40-70) stipulates the inclusion of technology-based effluent concentration limits in the individual permit for any facility that has installed technology for the control of nitrogen and phosphorus whether by new construction, expansion, or upgrade. Technology-based annual average effluent concentration limits of TN = 6.0 mg/L and TP = 0.5 mg/L have been required for the 3.0 mgd flow tier and limits of TN = 3.0 mg/L and TP = 0.25 mg/L have been required for the 6.0 mgd flow tier. At these annual average concentrations and design flows, the load limits will be met without the need to offset any nutrient loads.

There is some movement in Virginia and other Chesapeake Bay states to expand trading programs beyond point-to-point sources to encompass non-point sources as well. Virginia allows point-to-non-point trades now to offset added loads associated with wastewater facility expansions, but such trades have occurred infrequently. Virginia is also working on regulations that would open trading among all sources (e.g., stormwater from construction, industrial, and MS4s), however near term issues of trading ratios between non-point and point source nutrient mass loads and details of certifying non-point credit generation (Virginia DEQ, 2014b) remain to be resolved.

As part of Chesapeake Bay TMDL compliance requirements, each state in the watershed is required to develop Phase I and Phase II WIPs, which contain details on how each state intends to implement TMDL provisions in their own NPDES permitting programs and consider trading and other strategies. For example, the Virginia Phase I WIP (Virginia DEQ, 2010) included creation of a watershed cap on nutrient loads from significant point source dischargers, as well as creation of a nutrient credit exchange program. The Virginia Phase II WIP (Virginia DEQ, 2012a) focuses primarily on agricultural, stormwater, and septic issues, but also reports on the expansion of the nutrient credit trading program. Regarding wastewater, the Phase II WIP provides some technical changes to Phase I WIP strategies and presents an updated approach for permitting of CSOs.

9.3.3 Neuse River Compliance Association, North Carolina

Significant loadings of nitrogen from the Neuse River Basin have created excess algal growth in the Neuse River Estuary as far back as the 1980s, and a TMDL for nitrogen was developed in 1999. The Neuse River Compliance Association (NRCA), a non-profit organization, was founded in 2002 (LNBA, 2014) to establish a total nitrogen trading program for NPDES dischargers in the basin. Dischargers may join or leave the NRCA each permitting cycle.

In the 2012 NRCA NPDES permit (North Carolina, 2011), there are 21 co-permittees who can buy or lease total nitrogen allocations. Both point source to point source, and point source to nonpoint source transactions are available. The NPDES permit does not explicitly mention "water quality trading", but has enabling language: *"... allowable changes in TN Allocations include…purchase, sale, trade, or lease of allocation among the Association, its members, and non-member dischargers*." It is interesting to note that NCRA members can acquire allocations from facilities within the NCRA as well as point sources outside of the NRCA.

9.3.4 Minnesota River Basin General Phosphorus Permit

Depressed DO levels in the Lower Minnesota River during summer low flow conditions have been attributed to excess phosphorus loading from upstream sources. A TMDL for dissolved oxygen was developed in 2004 and phosphorus allocations were assigned to both point and non-point sources.

A collective of dischargers in the Minnesota River Basin are covered under a joint NPDES permit with respect to phosphorus (Minnesota River Basin General Phosphorus Permit Phase I, MNG420000) (MPCA, 2009). In the general permit there are 47 co-permittees who can both buy and sell within the group. A standardized trading unit to relate phosphorus discharges to turbidity and lowered dissolved oxygen levels in the Lower Minnesota River was established, as well as a factor to adjust for how far a discharger is upstream of the Lower Minnesota River. Although this permit expired in 2010, the discharge limits remain applicable.

An example individual permit subject to compliance with the TMDL and the general phosphorus permit is the City of Redwood Falls WWTP (NPDES Permit MN0020401), which has a design capacity of 1.321 mgd (MPCA 2013, 2014). In the general phosphorus permit, the Redwood Falls facility was given a trading baseline of 1,277 kg TP (May through September) for the years 2006 and 2007, and effluent limits of 1,174 kg (2008), 1,105 kg (2009), and 1,036 kg (2010). The final limit for 2015 is 1.0 mg TP/L or the final TMDL goal. It was determined that the facility is not required by state rules to receive a 1.0 mg TP/L limit.

An interesting complication is that the Minnesota River empties into the Mississippi River in the Minneapolis-St. Paul metropolitan area. A run-of-the-river lake, Lake Pepin, is located downstream of this confluence and has a TMDL for nutrients with draft total phosphorus criteria. It was determined that the facility is required to have a water quality-based effluent limit for phosphorus based on the downstream Lake Pepin TMDL. The facility wasteload allocation was determined to be 1,460 kg TP/yr (1.321 mgd X 0.8 mg/L X 3.785 L/gal X 365 days/yr). This is more restrictive than the general phosphorus permit for the Minnesota River Basin.

The facility has been given two alternatives to comply with the downstream phosphorus wasteload allocation upon completion of a "Wastewater Treatment Study". Track 1 pertains to phosphorus trading (MPCA, 2015a), while Track 2 pertains to facility improvements/expansion to meet the wasteload allocation.

9.3.5 Idaho Policy and City of Boise Nonpoint Source Phosphorus Offset

At the request of the Idaho Legislature, a study was performed to address two water quality programs, revising water quality standards and implementing water quality trading (Idaho Legislature, 2014a). Idaho is one of four states that has not fully assumed primacy for the NPDES permitting program from EPA. However, in 2014 the Idaho Legislature passed House Bill 406 to begin the process of taking over the NPDES program (Idaho Legislature, 2014b). In regards to water quality trading, the report states that:

"The water quality trading model being pursued in Idaho, more specifically on the lower Boise River, would be a case-by-case model. Trades could occur between any two dischargers but likely would occur between a point and nonpoint source or between two point sources. The two entities would enter into a voluntary agreement, outlining the specifics of the trade including the amount of pollutant reduction, life of the project, and the amount of money exchanged between parties. An independent party, or trade broker, would match parties seeking to participate in trade agreements. Before trading could occur, the discharge permit would need enabling language added to authorize the trade."

The report concludes that:

"The three most important preconditions for Idaho to work on, in sequential order, are 1) completing TMDLs where necessary, 2) establishing trading frameworks, and 3) incorporating trading language in pollutant discharge permits."

9.3.5.1 City of Boise NPDES Permit and the Dixie Drain Treatment Facility

The City of Boise's West Boise wastewater treatment facility (WWTF) discharges to the Boise River, which eventually flows into the Snake River. The Boise River flows into the Snake River where the Snake River/Hells Canyon TMDL for phosphorus was approved in 2004. All tributaries to the Snake River, including the Boise River, are required to reduce their phosphorus levels. For the Boise River, that means a reduction of more than 75% at the river mouth (Malmen, 2014). A phosphorus TMDL for the Boise River is being developed and expected to be completed in 2015. The Boise River phosphorus TMDL incorporates the Snake River/Hells Canyon in-stream phosphorus target concentration of 70 μg/L as a downstream boundary condition.

In the most recent NPDES permit for the West Boise facility, a seasonal (May 1 through September 30) total phosphorus effluent limitation of 70 μg/L was included, along with a compliance schedule and interim limits (City of Boise, 2012). The City of Boise investigated opportunities to develop phosphorus load reductions elsewhere in the Boise River basin as a means to optimize phosphorus load reduction requirements. The Dixie Drain is an agricultural stream that flows into the Boise River near the river mouth and has high May-September phosphorus concentrations (~381 µg/L). In an effort to reduce the overall phosphorus impact of both the West Boise WWTF and the Dixie Drain to the Boise and Snake Rivers, an offset strategy was developed and included in the NPDES permit.

The City proposed the Dixie Drain Treatment Facility consist of a diversion structure that routes some of the Dixie Drain water into a 49-acre treatment system to remove phosphorus. Diverted water from the Dixie Drain will first pass through a sedimentation basin, followed by flow through wetland cells. Water will then receive alum dosing as needed to flocculate phosphorus, which will then settle and later be removed. Water will then be returned to the Dixie Drain with a greatly reduced phosphorus concentration. The Dixie Drain Facility is required to have an annual TP removal efficiency of 70%, and it is anticipated that the facility will remove 136 pounds of total phosphorus per day (Malmen, 2014).

Table 9-3 illustrates the structure of the Boise NPDES permit with the final effluent phosphorus limits. For each pound of total phosphorus that the West Boise facility discharges in excess of 70 µg/L, it must remove a minimum of 1.5 pounds of total phosphorus at the Dixie Drain Facility.

Table 9.3. West Boise WWTP NPDES Permit Effluent Phosphorus Limits.

Parameter	Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit
Total Phosphorus[2] May 1 – Sept 30	70 µg/L 14 lbs/day	84 µg/L 16.8 lbs/day	–
Note 2. The permittee may meet the effluent limits for total phosphorus using the Dixie Drain offset. See Part I.B.6.			

Part I.B.6. of the Boise NPDES permit describes Dixie Drain Offset and linkage to the compliance schedule:

"6. Dixie Drain Offset. The permittee may meet the final effluent limits for total phosphorus through a combination of removal of total phosphorus at the West Boise Wastewater Treatment Facility and from the Dixie Drain at the Dixie Drain Treatment Facility. The offset is available when the final total phosphorus effluent limits are required (10 years from the effective date of the permit, see Part I.C. for the compliance schedule). Components of the Dixie Drain Offset include:

- *Effluent limits at the West Boise Treatment Facility to prevent localized impacts, i.e., concentrations immediately downstream from the West Boise Treatment Plant from exceeding 70 µg/L.*
- *Offset removal requirements for the Dixie Drain Treatment Facility.*
- *Interim removal requirements from the Dixie Drain Treatment Facility. The interim removal requirements begin when the facility begins operation. See Part I.C.4 for the compliance schedule for the Dixie Drain Treatment Facility. These interim removal requirements may not be used to offset the interim total phosphorus effluent limits."*

Part I.B.6.b of the Boise NPDES permit describes in detail how the Dixie Drain Offset is to be calculated with the trading ratio:

"b) Offset Pounds. For each pound of total phosphorus the West Boise Treatment Facility discharges in excess of 70 µg/L, the Permittee must remove a minimum of 1.5 pounds of total phosphorus at the Dixie Drain Facility. The pounds of total phosphorus the West Boise Treatment Facility discharges in excess of 70 µg/L are calculated as:

(Average Monthly Effluent Concentration – 70) × Average Monthly Flow × 8,340 ÷ 1,000.

The monthly offset ratio which is defined as the pounds of total phosphorus removed at the Dixie Drain Facility divided by the pounds of total phosphorus the West Boise Treatment Facility discharges in excess of 70 µg/L must be greater than 1.5.

Pounds Removed Dixie Drain Facility/Pounds Discharged at West Boise in Excess of 70 µg/L > 1.5".

The West Boise NPDES permit includes a compliance schedule with interim phosphorus limits that provide for the time necessary to implement the Dixie Drain project and the phosphorus removal facilities at the West Boise plant, as shown in Table 9-4. The West Boise facility is allowed three years at a lenient seasonal average effluent phosphorus limit of 5.8 mg/L. In 2016, the effluent from the treatment plant must be reduced to a seasonal average of 600 ug/L, followed by a decrease to 500 ug/L beginning May 1, 2017, and then seasonally thereafter until the final limits are achieved. Compliance with the final effluent limits equivalent to 70 µg/L total phosphorus by a combination of phosphorus removal at West Boise and the Dixie Drain is to be accomplished in 10 years.

Table 9-4. West Boise NPDES Interim Effluent Phosphorus Limits and Compliance Schedule.

Date	Effluent Limit
May 1, 2013 through September 30, 2013	Not to exceed 5.8 mg/L measured as a seasonal average
May 1, 2014 through September 30, 2014	Not to exceed 5.8 mg/L measured as a seasonal average
May 1, 2015 through September 30, 2015	Not to exceed 5.8 mg/L measured as a seasonal average
May 1, 2016 through September 30, 2016	Not to exceed 600 µg/L measured as a seasonal average
May 1, 2017 through September 30, 2017 and May 1 through September 30 every year thereafter until the final limit is achieved	Not to exceed 500 µg/L measured as a seasonal average limit
10 years from the effective date of the permit	See Part I.B.3, for final effluent limits (as shown in Table 9-3 above)

9.3.6 Washington Water Quality Offsets and Spokane County

Washington Administrative Code (WAC) provides a regulatory pathway to allow water quality offsets between a point source and a nonpoint source. Spokane County utilized these provisions to develop an offset based on septic system abatement in a large urbanized area to provide receiving water capacity for the discharge from a new regional reclamation facility. WAC 173-201A-450 states that water quality offsets may be allowed by the Washington Department of Ecology when all of the following conditions are met:

"(a) Water quality offsets must target specific water quality parameters.

(b) The improvements in water quality associated with creating water quality offsets for any proposed new or expanded actions must be demonstrated to have occurred in advance of the proposed action.

(c) The technical basis and methodology for the water quality offsets is documented through a technical analysis of pollutant loading, and that analysis is made available for review by the department. The methodology must incorporate the uncertainties associated with any proposed point or non-point source controls as well as variability in effluent quality for sources, and must demonstrate that an appropriate margin of safety is included. The approach must clearly account for the attenuation of the benefits of pollution controls as the water moves to the location where the offset is needed.

(d) Point or non-point source pollution controls must be secured using binding legal instruments between any involved parties for the life of the project that is being offset. The proponent remains solely responsible for ensuring the success of offsetting activities for both compliance and enforcement purposes.

(e) Only the proportion of the pollution controls which occurs beyond existing requirements for those sources can be included in the offset allowance.

(f) Water quality offsets must meet antidegradation requirements in WAC 173-201A-300 through 173-201A-330 and federal antibacksliding requirements in CFR 122.44(l)."

9.3.6.1 Spokane County Septic System Abatement Phosphorus Offset

Draft versions of a DO TMDL for the Spokane River called for effluent total phosphorus levels of 10 µg TP/L and a revised draft TMDL published in May 2008 went still lower to 8 µg TP/L. Since these requirement were below the limits of treatment technology the Spokane County, Washington Division of Utilities developed a creative approach to off-setting its point source discharge by reducing a non-point source phosphorus loading (Clark et al., 2008). Spokane County provided sewer service to a large unsewered area to reduce non-point source loadings from on-site septic systems to trade with the point source discharge to the Spokane River to meet the TMDL loading requirements. Phosphorus soil breakthrough analysis was used to develop a water quality offset from elimination of on-site septic systems contributing P to groundwater and the Spokane River. WAC 173-201A-450 provided the regulatory basis for the septic system phosphorus reduction water quality offsets.

At the time of the development of the septic loading offset, Spokane County was in the process of planning to implement a new Regional Water Reclamation Facility with a discharge flow rate of 8 mgd. This flow rate multiplied by the target TP concentration of 10 µg TP/L results in a target load of 0.67 lbs TP/day. The limit of treatment technology for low phosphorus concentrations in effluent is generally assumed to be approximately 50 µg TP/L. This concentration multiplied by the design flow rate of 8 mgd results in a load of 3.34 lbs TP/day. For Spokane County to meet the target load of 0.67 lbs TP/day for an 8 mgd water reclamation facility, a combination of treatment technology and other P reduction efforts was envisioned to be necessary. Based on the target load, the other P reduction efforts, or offset requirement, is 3.34 lbs TP/day minus 0.67 lbs TP/day or 2.67 lbs TP/day. The Clark et al. (2008) study describes the processes of P loading from onsite sewage disposal systems to groundwater and quantifies these loads to the aquifer and the Spokane River system.

In the Spokane County Regional Water Reclamation Facility NPDES permit (Spokane County, 2011) the effluent limits reflect the work of Clark et al. (2008). While the initial effluent limits for TP during the March 1 to October 31 period were set at 2.80 pounds TP/day, an alternate limit of 3.34 pounds TP/day was stated to be equivalent with respect to TMDL baseline values:

"During the start-up period, 2011, 2012 and 2013, the Permittee may use the "offset" total phosphorus from septic tank eliminations identified in the approved wastewater facilities plan as amended in November 2011, to offset the DO depleting value of CBOD5, total ammonia, or total phosphorus up to the value of the total phosphorus used in the approved offset scenario submitted to and approved by Ecology. The amount of offset used for this is to be identified in the transmittal letter accompanying the monthly discharge report, DMR. The transmittal letter will maintain a running total of offsets used through the applicable season."

The final version of the Spokane River dissolved oxygen TMDL was published in 2012 and included more lenient effluent wasteload allocations than in earlier drafts of the TMDL. The final wasteload allocations were equivalent to 36 μg TP/L for dischargers in Idaho and 42 μg TP/L for dischargers in Washington. Customized water quality modeling scenarios demonstrated that dischargers could discharge effluent of 50 μg TP/L on a seasonal basis in conjunction with reductions in effluent CBOD and ammonia nitrogen, depending upon a number of factors. Table 9-1 presented earlier in this chapter illustrates the structure of the Spokane County NPDES permit with seasonal mass loading limits for phosphorus, CBOD, and ammonia nitrogen. The water quality offset provisions of the permit are included in two ways, to address compliance with effluent limits during early operations of the new treatment facility, and in long-term compliance with effluent limits. Special Conditions to the discharge limits provide for Spokane County to use phosphorus offsets as follows:

"S1.B Alternate effluent limits for oxygen consuming pollutants demonstrated to be equivalent to DO TMDL baseline effluent limits in S1.A.

During the start-up period, 2011, 2012 and 2013, the Permittee may use the "offset" TP from septic tank eliminations identified in the approved wastewater facilities plan as amended in November 2011, to offset the DO depleting value of CBOD5, total ammonia, or TP up to the value of the total phosphorus used in the approved offset scenario submitted to and approved by Ecology. The amount of offset used for this is to be identified in the transmittal letter accompanying the monthly discharge report, DMR."

Footnote f. to the effluent limits table of the NPDES permit provides for Spokane County to use phosphorus offsets as follows:

"Compliance with the effluent limitations for CBOD5, NH3-N and TP will be based on:

1) a seasonal average with the running seasonal average for the season reported monthly for tracking compliance with the allowable mass limitation, and

2) a combination of reported effluent quality, pollutant equivalencies in term of oxygen depletion and pollutant credits earned from Septic Tank Eliminations and approved by Ecology, following a revised run of the current, 2011, CE-QUAL-W2 model demonstrating compliance with DO TMDL wasteload allocation and permit conditions. The model run results and accompanying documentation will be submitted to the DO TMDL advisory committee for review and to Ecology for review, comment (if needed) and Ecology approval."

9.3.7 Pacific Northwest Trading Policy

In 2013 the Willamette Partnership began facilitating water quality agency staff from Idaho, Oregon, and Washington, U.S. EPA Region 10, and The Freshwater Trust in an ongoing discussion of developing a water quality trading policy in the Pacific Northwest. A draft report of regional recommendations was released in 2014 (Willamette Partnership, 2014) and focuses on trades between point sources and non-point sources. Regarding nutrients and NPDES permitting, the report identifies the NPDES permit components necessary for a water quality trade:

- Identification of trading parameters, units, and quantity needed to offset effluent limits in the NDPES permit.
- Compliance point.
- Discharge monitoring reporting.
- Compliance schedules.
- Compliance with anti-degradation policy.
- Compliance with anti-backsliding policy.
- Incorporating trading components in permit special conditions.
- Timeline to develop trading plan.
- Reporting obligations beyond DMR submission.
- Additional Conditions Imposed by 401 Certifications.
- Liability for project performance.
- Eligible credit buyers.
- Eligible trading areas.
- Eligible pollutants and units for trading.
- BMP guidelines.
- Process for eligible BMPs for trading.

The draft report provides further details on each of these topics. The final report (anticipated in late 2015) is intended to include a set of recommended practices for each state to consider as they develop water quality trading policies.

9.3.8 Nutrient Trading in Missouri

Missouri does not have state numeric nutrient criteria yet, but recent interest in nutrient water quality trading (WQT) prompted a study to help identify the challenges of successfully implementing a statewide WQT program (Geosyntec, 2013). A simulated nutrient trading exercise took place for two in-state watersheds; trading opportunities for dischargers to the Missouri and Mississippi Rivers were also evaluated, but on a qualitative basis. The major conclusions of the study as they pertain to wastewater treatment plants are as follows (Geosyntec, 2013):

- *Trading areas should be as large as possible*. If point source nutrient compliance is measured as an overall loading cap that must be met at some downstream lake or major river confluence, watershed-scale trading would be an appropriate trading area. If instead, the driver is a nutrient criterion which point sources must meet "end of pipe," an upstream-only trading requirement may be necessary to limit unacceptable hot spots downstream. However, wastewater treatment plants may have limited upstream area from which to purchase credits.

- *Trading ratios impact the feasibility of a WQT program*. Using high trading ratios that require wastewater treatment plants to more than offset their loadings essentially taxes them for participating in the program and will likely limit the number of facilities willing to purchase BMP credits.
- *Point-to-point trading is the most cost-effective option in some situations*. In general, advanced levels of nutrient treatment are more cost-effective for larger wastewater treatment plants than for smaller facilities. Additionally, in some situations advanced treatment is more cost-effective than trading with nonpoint sources. Both point-to-nonpoint and point-to-point source trading are necessary in a WQT program to maximize efficiency.
- *Drivers for Big River trading are different than for other waters in the state*. Future Big River nutrient targets may be focused on addressing the hypoxic zone in the Gulf of Mexico rather than protecting against localized impacts. Because upgrade costs will generally decrease with facility size, larger (>10 mgd) Big River wastewater treatment plants could cost-effectively address nutrient removal requirements for the majority of smaller Big River dischargers.
- *Wastewater treatment plants should be free to set the top of the trading margin*. The freedom to explore creative and cost-effective solutions under a WQT program is compromised where wastewater treatment plants must first adopt some minimum level of control technology or level of treatment. The most cost-effective combination of control technology and WQT is not the same for every facility. Efficiencies are likely gained where treatment plant operators are free to explore creative solutions for optimizing plant operations. Capping the top of a trading margin through minimum control technologies also raises issues of equity. If wastewater treatment plants are required to first maximize nutrient reductions through control technologies, then trading represents an additional expense that would never have been incurred in the absence of a WQT program. Capping the top of a trading margin through minimum control technologies or level of treatment will result in less cost-effective solutions for wastewater treatment plants.
- *Administrative burdens and transaction costs may prohibit direct trading for the majority of wastewater treatment plants*. Larger wastewater treatment plants have a significant advantage when it comes to negotiating a trade, particularly with respect to minimizing transaction and administrative costs because costs can be spread over a larger number of credits. Conversely, smaller wastewater treatment plants have relatively higher transaction costs and administrative burdens because they are purchasing fewer credits.
- *Liability, monitoring and enforcement require special consideration in the context of trading*. The CWA does not allow point sources to transfer legal liability for meeting NPDES permit limits to a nonpoint source. Directly measuring water quality improvements resulting from the implementation of all BMPs in a trading program would be complicated and prohibitively expensive. Therefore, it would be impracticable to base enforcement measures on water quality monitoring data in a point-to-nonpoint trade.
- *Agricultural baselines effectively behave like a trading ratio*. Any baseline set above and beyond current nutrient management practices would result in additional trading costs. These costs would be passed on to wastewater treatment plants purchasing credits and, in effect, would act as a trading ratio because credit supplies would become more limited and trading

would be less cost effective. Baselines also raise issues of equity as wastewater treatment plants are effectively paying for nutrient removal activities beyond that required by regulation. If the agricultural baseline is set higher than current nutrient management practices, WQT will be less cost-effective, fewer wastewater treatment plants will be able to trade, and issues of equity will be raised.

9.4 Filtered and Unfiltered Flow Issues

Compliance with effluent phosphorus limits at very low concentration levels generally less than 0.250 to 0.50 mg/L requires the use of chemical coagulants and effluent filters. Effluent filter sizing is controlled by hydraulic loading rates and the peak flow routed to effluent filtration generally governs sizing. Since effluent filtration is an expensive tertiary process to capitalize and operate, it is desirable to avoid unnecessary oversizing of the effluent filters based on treating extreme peak flows that rarely occur. This is especially the case with microfiltration membranes, which can be very effective in producing very low effluent phosphorus, but have a narrow band of peak to average flow capabilities (approximately <1.5:1 on a maximum day flow basis). Consequently, if may be advantageous to design for a combination of filtered and unfiltered effluent to be produced during rare peak flow events to avoid oversizing of effluent filters, providing that effluent phosphorus limits can be attained. However, a complicating factor that potentially impacts this practice is the bypass provision included in NPDES permits.

Federal regulations prohibit bypassing, which is defined as the intentional diversion of waste streams from any portion of a treatment facility. There are mandatory bypass prohibitions included in all NPDES permits. Typical permit bypass provisions are as follows:

"3. Prohibition of bypass.

a) Bypass is prohibited, and the Director of the Office of Compliance and Enforcement may take enforcement action against the permittee for a bypass, unless:

(i) The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventive maintenance; and

(iii) The permittee submitted notices as required under paragraph 2 of this Part.

b) The Director of the Office of Compliance and Enforcement may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed above in paragraph 3.a. of this Part."

The NPDES regulations also state that the prohibition of bypass applies even where the permittee does not violate permit limitations during the bypass. However, bypasses for essential equipment maintenance may be allowed if effluent limitations are not exceeded.

Nationally, blending has been a controversial issue because of unresolved peak wet weather flow policies. Blending is a common practice at many wastewater facilities during peak flow events when some portion of the primary effluent flow is routed around the secondary treatment process to combine and satisfy secondary requirements. However, this is blending to meet technology-based secondary treatment limits for BOD and total suspended solids, which is entirely different from a tertiary process combining filtered and unfiltered effluent which far exceeds secondary treatment standards. Nevertheless, the bypass provisions of NPDES permits are worded so strongly that the issue of whether or not combining filtered and unfiltered effluent to meet phosphorus limits results in a potential compliance issue is unclear.

The lack of clarity on blending does aid in addressing the issues of combining tertiary filtered and unfiltered flows. Blending to meet secondary effluent requirements has been the topic of litigation and the subject of a notable 8th Circuit Court of Appeals ruling in Iowa League of Cities v. EPA where the court ruled that EPA had no authority under the CWA to specify how municipalities design their treatment facilities within the plant fence line (U.S. Court of Appeals, 2013). EPA contends that this court ruling only applies in the 8th Circuit. The EPA has decided to limit the application of the decision to only those states in the 8th Circuit (Arkansas, Iowa, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) and to consider the Court's decision on a case by case basis in other states.

9.4.1 City of Meridian, Idaho

The City of Meridian, ID, has considered utilizing different tertiary filters for different effluent management plans (reuse and surface water discharge) and seeks to optimize effluent filter sizing by combining filtered and unfiltered flows during peak flow events for surface water discharge with phosphorus limitations. However, inclusion of the standard NPDES permitting language prohibiting bypasses has introduced some concerns in the development in the City's NPDES permit renewal. A compliance order from EPA in 2009 specifically refers to the installation of effluent filters in a requirement to upgrade the filters to treat the entire 7 mgd design flow at the Meridian facility (U.S. EPA, 2009). The compliance order does not address the issue of peak flow routing around the filters.

In an effort to avoid having the use of filtered and unfiltered flows be considered bypassing, and to alleviate the potential non-compliance issues, EPA Region 10 was engaged in a dialog in the course of the NPDES permit renewal process. Some historical language in the Federal Register from the preamble of a 1984 revision to the "bypass" section of the National Pollutant Discharge Elimination System (NPDES) regulations (40 CFR 122.41(m)) was identified that may alleviate some of the concerns (Federal Register, 1984):

"Seasonal effluent limitations which allow the facility to shut down a specific pollution control process during certain periods of the year are not considered to be a bypass. Any variation in effluent limits accounted for and recognized in the permit which allows a facility to dispense with some unit processes under certain conditions is not considered bypassing."

This language may address the issue of filtered and unfiltered flow being considered a bypass with respect to seasonal effluent limits.

9.4.2 Denver Metro Wastewater Reclamation District

The Denver Metro Wastewater Reclamation District (MWRD) operates the largest wastewater facility in the Rocky Mountain West (220 mgd capacity). The MWRD currently treats about 140 mgd of wastewater, discharging it into the nearby South Platte River, where for nine months of the year it constitutes nearly 85% of the river's flow northeast of the plant. Preliminary design for plant upgrades to comply with future nutrient limitation are in progress and the Colorado Department of Public Health and Environment (CDPHE) was engaged in a dialog about tertiary filtration practices and design criteria.

Colorado wastewater design criteria (CDPHE, 2012) is very clear on what processes can have bypasses (screening, grit), and what processes absolutely cannot have bypasses during peak flow events (disinfection). Section 7.15.0 of the Colorado criteria address tertiary filtration used to remove constituents (including nutrients) following conventional secondary treatment. Regarding granular media filtration, the document states:

"A facility using filtration must have a minimum of two filter units. Firm capacity shall have a capacity of at least 50 percent of the total peak hour design flow."

This language seems to conflict with the bypassing issues referred to previously in this chapter. The Federal Register (1984) language cited above may provide some clarity regarding nutrient NPDES permitting issues that may be encountered in Colorado.

9.5 Nondegradation and Permitting

The term nondegradation means that in no case will standards allowing for less than existing water quality be acceptable and all discharges shall receive the best practicable treatment or control (DOI, 1968). Section 303 (Title 33 of United States Code [U.S.C.] 1313) of the CWA requires states and authorized tribes to adopt water quality standards for waters of the U.S. within their applicable jurisdictions. Water quality standards must include, at a minimum: 1) designated uses for all waterbodies within their jurisdictions; 2) water quality criteria necessary to protect the most sensitive of the uses; and 3) antidegradation provisions. The federal term "antidegradation" is equivalent to "nondegradation" (MPCA, 2008). Nondegradation has been addressed in other discussions as it relates to nutrient management (Clark, 2010). The goal of nondegradation is to maintain existing water quality conditions that are superior to the water quality standards.

The concept of nondegradation has existed for many decades. However, further definition and implementation of the concept has mostly been left to the states (Glicksman, 2011). Montana is one of the states that have advanced the concept as it relates to nutrient NPDES permitting. Nondegradation includes consideration of whether or not a discharge is in compliance with the provisions the nondegradation policy, whether the discharge will result in a decline in water quality, and whether minimum treatment requirements must be implemented. Degradation that impacts established beneficial uses is not allowed.

Montana's nondegradation policy is implemented through discharge permits (U.S. EPA, 2005). In drafting a permit, the permit writer must determine whether the proposed discharge of pollutants is a new or increased source. If the proposed discharge is not a new or increased source, the nondegradation requirements do not apply. If the proposed discharge is a new or increased source, the permit writer must determine whether the pollutant will cause significant degradation. If the proposed discharge will cause significant degradation, the permittee has the following options (in Montana): submit additional information to demonstrate that the pollutant discharge will not cause significant degradation; reduce the pollutant load to a level that will not cause significant degradation; submit an application for an authorization to degrade State waters; or appeal the determination to the state's Board of Environmental Review.

9.6 Anti-Backsliding and Permitting

Anti-backsliding refers to statutory and regulatory provisions that prohibit the renewal, reissuance, or modification of an existing NPDES permit that contains effluent limitations, permit conditions, or standards less stringent than those established in the previous permit (U.S. EPA, 2010b). When a permit writer determines that effluent limits for a pollutant in permit renewal, or that any of the permit limitations are less stringent than the previous permit, an anti-backsliding analysis must take place. Exceptions do exist where less stringent limitations are acceptable, but the determination of applicability requires careful examination of both statutory and regulatory provisions.

Anti-backsliding may become a factor in the renewal of NPDES permits with nutrient limits when historical effluent performance exceeds that required by an existing permit, or when receiving water quality studies, such as TMDLs, are incomplete and lead to uncertainty about the need for future effluent limits. Permit writers may be inclined to restrict effluent limits to historical performance levels and cite anti-backsliding regulatory provisions. This circumstance has led to a reluctance on the part of wastewater utilities to explore optimization of existing treatment processes for nutrient removal because demonstrating an ability to reduce effluent nutrient levels might result in expectations to continue that performance. This is especially of concern in situations where under-loaded wastewater facilities operating at less than full design loadings use available treatment reactor capacity to pursue nutrient removal processes. Later, as flows and loads increase to the originally intended design capacity, it may not be possible to sustain the nutrient removal process explored earlier.

9.6.1 Anti-Backsliding Analysis

CWA, Section 402 National Pollutant Discharge Elimination System, includes a prohibition on backsliding in Section 402 (o)(1) as follows:

(o) Anti-backsliding.

(1) General prohibition
In the case of effluent limitations established on the basis of subsection (a)(1)(B) of this section, a permit may not be renewed, reissued, or modified on the basis of effluent guidelines promulgated under section 1314(b) of this title subsequent to the original issuance of such permit, to contain effluent limitations which are less stringent than the comparable effluent limitations in the previous permit. In the case of effluent limitations established on the basis of section 1311(b)(1)(C) or section 1313(d) or (e) of this title, a permit may not be renewed, reissued, or modified to contain effluent limitations which are less stringent than the comparable effluent limitations in the previous permit except in compliance with section 1313(d)(4) of this title.

Section 402 (o)(2) of the CWA provides for exceptions to anti-backsliding as follows:

(2) Exceptions
A permit with respect to which paragraph (1) applies may be renewed, reissued, or modified to contain a less stringent effluent limitation applicable to a pollutant if -

(A) material and substantial alterations or additions to the permitted facility occurred after permit issuance which justify the application of a less stringent effluent limitation;

(B)

(i) information is available which was not available at the time of permit issuance (other than revised regulations, guidance, or test methods) and which would have justified the application of a less stringent effluent limitation at the time of permit issuance; or

(ii) the Administrator determines that technical mistakes or mistaken interpretations of law were made in issuing the permit under subsection (a)(1)(B) of this section;

(C) a less stringent effluent limitation is necessary because of events over which the permittee has no control and for which there is no reasonably available remedy;

(D) the permittee has received a permit modification under section 1311(c), 1311(g), 1311(h), 1311(i), 1311(k), 1311(n), or 1326(a) of this title; or

(E) the permittee has installed the treatment facilities required to meet the effluent limitations in the previous permit and has properly operated and maintained the facilities but has nevertheless been unable to achieve the previous effluent limitations, in which case the limitations in the reviewed, reissued, or modified permit may reflect the level of pollutant control actually achieved (but shall not be less stringent than required by effluent guidelines in effect at the time of permit renewal, reissuance, or modification). Subparagraph (B) shall not apply to any revised waste load allocations or any alternative grounds for translating water quality standards into effluent limitations, except where the cumulative effect of such revised allocations results in a decrease in the amount of pollutants discharged into the concerned waters, and such revised allocations are not the result of a discharger eliminating or substantially reducing its discharge of pollutants due to complying with the requirements of this chapter or for reasons otherwise unrelated to water quality.

(3) Limitations
In no event may a permit with respect to which paragraph (1) applies be renewed, reissued, or modified to contain an effluent limitation which is less stringent than required by effluent guidelines in effect at the time the permit is renewed, reissued, or modified. In no event may such a permit to discharge into waters be renewed, reissued, or modified to contain a less stringent effluent limitation if the implementation of such limitation would result in a violation of a water quality standard under section 1313 of this title applicable to such waters.

If the effluent limitation is based on a water quality standard, there are three situations in which an exception to anti-backsliding may be allowed. First, water quality standards must be attained (Section 402(o)(1) and Section 303(d)(4)), the revision must be consistent with antidegradation (Section 303(d)(4)(B) attainment waters), and the revision complies with effluent guidelines and water quality standards including antidegradation (Section 402(o)(3)). A second pathway for an exceptions to anti-backsliding exists when water quality standards are not attained (Section 402(o)(1) and Section 303(d)(4)), the existing limit is based on a TMDL or wasteload allocation (Section 303(d)(4)(A) non-attainment waters), and the revision complies with effluent guidelines and water quality standards including antidegradation (Section 402(o)(3)). The third pathway for exceptions exists when a listed exception to anti-backsliding is met (Section 402(o)(2)), and the revision complies with effluent guidelines and water quality standards including antidegradation (Section 402(o)(3)).

The federal regulations state that "…when a permit is renewed or reissued, interim effluent limitations, standards, or conditions must be at least as stringent as the final effluent limitations, standards, or conditions in the previous permit." 40 C.F.R. 122.44(l)(1)

(l) Reissued permits.
(1) Except as provided in paragraph (l)(2) of this section when a permit is renewed or reissued, interim effluent limitations, standards or conditions must be at least as stringent as the final effluent limitations, standards, or conditions in the previous permit (unless the circumstances on which the previous permit was based have materially and substantially changed since the time the permit was issued and would constitute cause for permit modification or revocation and reissuance under section 122.62)

9.6.2 Kalispell, Montana Case Study

The City of Kalispell, Montana wastewater treatment plant was one of the first nutrient removal facilities in North America (1992) and has an excellent record of producing low effluent nitrogen and phosphorus. The treatment plant discharges into Ashley Creek, which flows into the Flathead River and then into Flathead Lake, which has an approved nutrient TMDL that called for an initial reduction in nitrogen and phosphorus loadings (U.S. EPA, 2002). A Phase II of the Flathead TMDL is pending and may result in a more restrictive wasteload allocation (MT DEQ, 2014d). The 2008 Montana Pollutant Discharge Elimination System (MPDES) permit established average monthly mass and concentration limits for total phosphorus (1 mg/L and 25.8 lb/day) and total nitrogen mass limit (286 lb/day) as shown in Table 9-5.

Table 9-5. City of Kalispell NPDES Permit Nutrient Limits Effective January 1, 2012.

Parameter	Units	Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit
Total Nitrogen	lb/day	286[a]	379	–
Total Phosphorus	mg/L	1.0	–	–
	lb/day	25.8	–	–

[a] The mass limit for nitrogen translates to an effluent concentration of approximately 11 mg/L at a flow rate of 3.1 mgd.

In 2014 the Montana DEQ promulgated numeric nutrient standards for wadeable streams (MT DEQ, 2014a), which apply during the July through September period each year. For Ashley Creek, the standards are 0.275 mg TN/L and 0.025 mg TP/L. If the in-stream standards were to be applied as end-of-pipe effluent limits because there was not sufficient assimilative capacity available in Ashley Creek, it would result in effluent limits that are lower than the capabilities of treatment technology. Montana adopted a general nutrient variance for permittees who are unable to comply with the base numeric standards in conjunction with the rulemaking. The variance provides for achievable technology-based effluent limits at 1 mg TP/L and 10 mg TN/L which would be effective for 20 years at which time the effluent limits based on the water quality standards are final and effective (MT DEQ, 2014b). The City of Kalispell applied for and received a general nutrient variance from Montana DEQ.

Although Kalispell was granted a general nutrient variance and expected to receive the technology-based effluent limits of 1 mg TP/L, the permit writer identified the 2015 renewal as a trigger for an anti-backsliding analysis since past treatment performance had produced lower effluent concentrations than the general nutrient variance limits. The average effluent phosphorus from the Kalispell plant has been approximately 0.12 mg/L. The permit writer has cited a guidance document (MT DEQ, 2014c) and proposed that a statistical analysis of past effluent performance be conducted for the period 2009 through 2014 using the effluent data shown in Figure 9-1. A performance statistic (95th percentile of past effluent phosphorus concentration) was applied to quantify historical effluent phosphorus and serve as the basis for a technology-based effluent limit. The 95th percentile of past Kalispell effluent phosphorus data is 0.23 mg TP/L, which is significantly more restrictive than the general nutrient variance level of 1 mg TP/L and presents a new 5 percent compliance risk for the City, even if they are able to maintain the excellent treatment performance from the past.

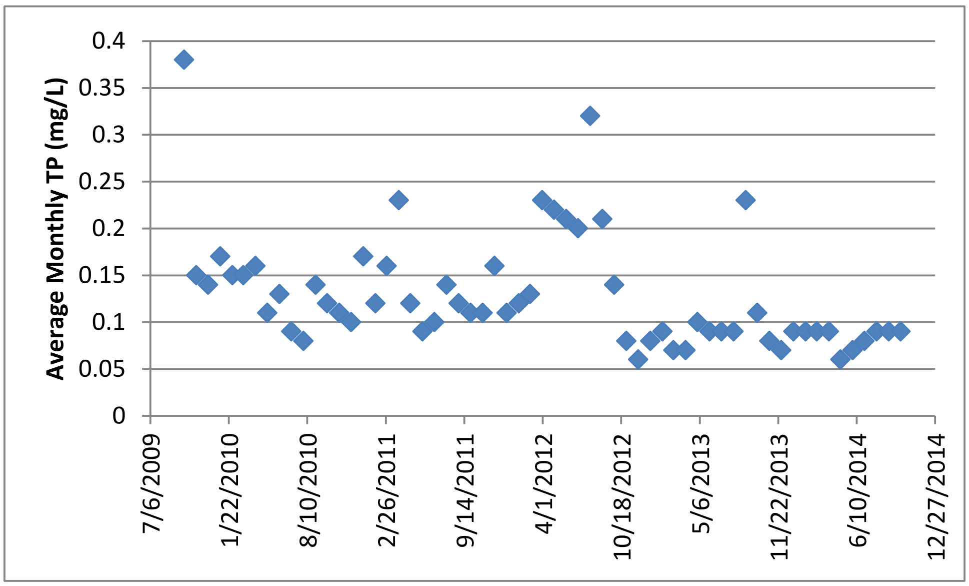

Figure 9-1. Kalispell Effluent Phosphorus Concentration (2009 – 2014).

CHAPTER 10.0

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions from the discussion of traditional approaches to effluent nutrient discharge permitting, as well as more appropriate approaches that incorporate treatment technology performance statistics, predictive water quality models, and probabilistic approaches. A great variety of approaches to establishing effluent limits for nitrogen and phosphorus have been used across the country and some have resulted in very restrictive conditions that may exceed the capabilities of advanced nutrient removal treatment. Overly restrictive effluent discharge permits generally result from the application of permitting approaches designed to protect receiving waters from short-term effects in the near field effluent mixing zone, such as the approach taken to control toxics.

In other cases, effluent nutrient limits have been tailored to the site-specific circumstances necessary to achieve receiving water quality objectives. This often results in more appropriate permit structures that reflect an understanding of both the impact of nutrient discharges on receiving waters and the capabilities of nutrient removal treatment. Tailoring nutrient permits to site-specific circumstances often results in the need to deviate from conventional effluent limit structures applied to other parameters and combine receiving water objectives with technically feasible treatment limits.

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 unnecessarily restrictive effluent discharge conditions that result in little additional water quality protection but consume inordinate amounts of energy and chemicals that result in other deleterious environmental impacts.

10.1 Nutrient Permitting Considerations

There are unique considerations regarding nutrients that a permit writer and permittee may examine when drafting a new permit or renewing an existing permit. These considerations are a part of applying appropriate approaches in the development of effluent nutrient limits, including the following:

- Advanced nutrient removal treatment is costly and complex.
- Nutrients should be distinguished from toxics.
- Effluent nutrient concentrations vary even in the best nutrient removal facilities.
- A variety of nutrient discharge permit structures have been successful.
- Flexibility in permitting promotes reuse, recharge and restoration.

Point source permitted dischargers are the most highly regulated sources subject to nutrient control requirements resulting from numeric nutrient standards, total maximum daily loads, and water quality-based permit limits. The costs for nutrient removal are substantial and vary widely depending upon existing treatment facilities and site-specific circumstances. While high levels of nutrient removal can be achieved in advanced wastewater treatment, nutrient removal processes require additional energy, chemicals, maintenance materials, and labor, which increase the complexity of plant operations and costs. It is therefore important that effluent nutrient permitting requirements are attainable from a treatment technology standpoint and protective of receiving water quality.

Surface water nutrient discharges should receive special consideration in discharge permitting. Unlike BOD, ammonia nitrogen, and some toxic pollutants that can have acute effects in the aquatic environment, total nitrogen and phosphorus generally have seasonal impacts on receiving waters. Therefore, distinction should be made from these other effluent parameters upon which much of the existing EPA permit writer's guidance is based. Appropriate NPDES discharge permit structures for nutrients should be based on long averaging periods linked to the specific waterbody response to nutrient enrichment, such as seasonal limits based on long-term average values, or total loading for the compliance period (e.g., total pounds discharged on an annual or seasonal basis).

It is also important that consideration be given to variability and reliability of effluent performance from advanced nutrient removal facilities, especially those operating at low or very low levels. Appropriate NPDES permitting methodologies will avoid compliance issues that are immaterial to surface water quality protection. Short-term limitations, such as maximum daily and maximum weekly, should not be imposed for nutrients. Technology performance statistics provide a science-based approach to characterize feasible effluent limits within the capabilities of advanced nutrient removal treatment and also characterize the variability in effluent performance and reliability of treatment.

Nutrient discharge permits that are restrictive in ways unrelated to water quality protection because of the structure of the permit itself should be avoided. Unnecessarily restrictive permits do not enhance water quality protection, but may create circumstances that result in noncompliance. From a sustainability standpoint, little additional nutrient removal is accomplished approaching the limits of treatment technology, however there are other environmental impacts that result from the additional use of energy and chemicals, and from increased atmospheric emissions.

A wide variety of nutrient permit structures have been utilized across the country and flexibility is available for permit writers to prepare permits for successful compliance with attainable treatment technology. WERF's Nutrient Removal Challenge research has provided detailed information about nutrient removal performance at full-scale facilities that informs both utilities and regulators about the effectiveness, variability, and reliability of treatment technology with performance statistics.

Finding the best combination of advanced treatment for nutrient removal and other watershed management practices presents a challenge for utility managers and regulators. Understanding the technically achievable and cost effective levels of advanced wastewater treatment is an important goal of the WERF Nutrient Removal Challenge research to help balance these competing demands. Nutrient permit structures that provide utilities with flexibility foster creative solutions to best meet overall water quality objectives, such as watershed permitting, shared loading capacity, and trading. Flexible permits can be developed to facilitate opportunities for effluent reuse, recharge, and restoration.

Continuing nutrient removal research is furthering the understanding of the science associated with the nitrogen and phosphorus remaining after advanced treatment that may not be removable with current treatment technology. Nitrogen and phosphorus speciation are important areas of nutrient research, both in terms of biodegradability in wastewater treatment and bioavailability in the water environment. At present, some nutrient discharge permits include effluent limits based on the inorganic fraction of nutrients that can be effectively removed in advanced treatment. In the future, discharge permits may also account for the bioavailability of nutrients in effluent in recognition of the changes that occur in advanced treatment.

10.2 Recommendations

Emphasis in nutrient discharge permitting should focus on providing the greatest amount flexibility possible in the structure of nutrient limits in order to preserve the opportunity for the most creative and economical approaches to managing nutrients. Traditional permit structures for publically owned treatment works generally include both monthly and weekly limits on both a concentration and mass basis. This may inadvertently eliminate the most effective watershed solutions to nutrient management by creating disincentives to wastewater dischargers to explore combinations of advanced wastewater treatment and other watershed management practices.

10.2.1 Water Quality Linkages

The most appropriate nutrient discharge permits will be prepared based on an understanding of both receiving water quality requirements and the capabilities of advanced nutrient removal treatment. Where either is lacking, an investment may be necessary to determine the level of nutrient management required to meet water quality objectives and link that analysis with specific objectives for effluent quality. When the relationship between nutrient loadings and water quality responses is not well defined, it is advisable to avoid overly restrictive effluent limits at the outset, since they may later prove unnecessary to meeting actual receiving water needs when they eventually become better understood. Preserving an opportunity for adaptive management approaches to guide the process of nutrient management over time may improve water quality incrementally, without overly restrictive discharge permits that result in over investment in advanced treatment. Permits structured around no net increase in existing loadings, or simple seasonal or annual loading reductions, may provide a foundation for adaptive management. In some cases, states in the process of adopting numeric nutrient criteria have used technology-based effluent limits to achieve some level of point source nutrient reduction while preserving the opportunity for adaptive management approaches. This has been found to be especially important where numeric nutrient criteria are very low concentrations of nitrogen and phosphorus that have the potential to result in water quality effluent limits beyond the capabilities of advanced nutrient removal treatment.

Where the linkages with water quality requirements are less well defined, the following approaches are recommended:

- Establish a foundation for adaptive management whereby the impact of nutrient loadings on receiving water quality can be better understood over time.
- In cases where nutrient limitations are warranted, develop nutrient discharge permit limits based on no net increase in existing loadings.
    - If necessary, utilize technology-based effluent limits at the basic biological nutrient removal level.
- Utilize compliance schedules in discharge permitting to provide the time necessary to develop a water quality-based set of requirements for effluent limits linked with water quality response variables.

Where the linkages with water quality requirements are defined but overall watershed nutrient management and nonpoint source controls are uncertain, the following additional approaches are recommended:

- Incorporate the most basic level of nutrient limits possible in discharge permits to preserve the ability to optimize the combination of point and nonpoint source nutrient controls through adaptive management.
  - When nonpoint source controls are uncertain, additional information should be gathered prior to considering point source controls.
  - Utilize mass loading limits or technology-based effluent limits at the basic biological nutrient removal level.

10.2.2 Technology Performance Statistics

When the linkage between water quality requirements and nutrient loadings result in the need for advanced levels of nutrient removal treatment, technology performance statistics provide a basis to define effluent performance and reliability.

Where the linkages with water quality requirements are not well defined, the following approaches are recommended:

- Consider whether technology performance statistics are warranted.

Where the linkages with water quality requirements are well defined, the following approaches are recommended:

- Utilize technology performance statistics to define effluent limits based on receiving water quality requirements in terms of effluent quality and reliability.
  - Where appropriate, utilize median statistics (50^{th} percentile) to define effluent quality such that inherent variability in treatment performance with advanced nutrient removal can be allowed.
  - Specify effluent limits in terms of average (50^{th}), 90^{th}, or 95^{th} percentile statistics depending upon the reliability of treatment required for receiving water conditions.
- Establish a foundation for adaptive management whereby the impact of nutrient loadings on receiving water quality can be better understood over time.

Where the linkages with water quality requirements are well defined but water quality-based effluent limits result in technically infeasible nutrient limits, the following approaches are recommended:

- Utilize the following regulatory implementation tools and define a level of feasible effluent performance for interim operation:
  - Site-specific nutrient criteria.
  - Compliance schedules.
  - Variances.
  - Use attainability analysis.

10.2.3 Predictive Water Quality Models

When water quality models are available to simulate the water quality response to nutrient loadings, discharge permit scenarios can be simulated to develop the basis for the most flexible and sustainable permit structure possible.

Where water quality models are available to define the impact on receiving water beneficial uses in terms water quality response variables (pH, DO, algae, etc.), the following approaches are recommended:

- Utilize water quality models to simulate receiving water quality responses to define effluent limits in terms of effluent quality and reliability.
- Utilize water quality models to simulate effluent discharges in alternative ways such that the critical factors affecting the response variables can be better understood, such as extended period simulations.
- Combine water quality modeling and monitoring in adaptive management approaches whereby the impact of nutrient loadings on receiving water quality can be better understood over time in pursuit of optimal watershed nutrient management.
    - Consider the changes in receiving water quality that occur following the initial reduction of point source nutrient loadings, along with each successive reduction in both point and nonpoint source loadings.
    - Select effluent nutrient limits that provide proportionate improvements in receiving water quality.
- Pursue sustainable combinations of point source nutrient removal and nonpoint source watershed nutrient management.
    - Avoid overly restrictive effluent limits that do not provide a commensurate improvement in receiving water quality, but may result in excessive use of energy and chemicals, and over production of residual biosolids.

10.2.4 Probabilistic Analysis

Where there is recognition that variability exists in receiving water flows and water quality, consider the application of probabilistic approaches to define levels of effluent performance to meet performance objectives and at what frequency. Extremely low receiving water flow conditions are not likely to coincide with maximum effluent discharge conditions. Likewise, aquatic life and recreational beneficial uses would generally not be thought to be impaired if a single rock, pool or riffle, or even a short reach of river had benthic algae higher than a target value. Probabilistic analysis can provide a tool to analyze the frequency at which specific conditions may occur in receiving waters based on variability in both effluent and receiving water.

Probabilistic analysis is recommended in the following circumstances:

- Where there are conditions in which there is a high degree of variability in receiving water and effluent flows and/or concentrations.
- Extremes in receiving water low flow conditions, or high ambient concentrations, are short lived or infrequent.

10.2.5 Watershed Permitting and Water Quality Trading

Since nutrients are often a broad watershed scale issue in terms of water quality, consideration should be given to watershed permitting. Watershed permitting provides a structure that allows for collaboration among point source dischargers, nonpoint sources, and other stakeholders to achieve watershed nutrient management objectives. Individual discharge permit renewal schedules and other administrative factors may artificially constrain the opportunity to develop and implement watershed scale permits. Approaching nutrient management considerations from the watershed scale, as opposed to individual permits, may reveal the opportunity for watershed permits to result in effective collaborations.

A potentially attractive tool in developing effective watershed scale nutrient management plans is nutrient trading. It is important to structure discharge permit in a manner that avoids inadvertent disincentives to nutrient trading. Combinations of both effluent concentration and mass effluent limits for nutrients may constrain the development of trades, or increase the complexity in accounting for trades. Watershed permits formulated with trading in mind may facilitate the implementation of water quality trading.

Recommendations are as follows:

- Structure NPDES discharge permits with long averaging periods linked to the specific waterbody response to nutrient enrichment, such as seasonal or annual limits based on long-term average values.
- Consider effluent limits based on the total loading for the compliance period (e.g., total pounds discharged on an annual or seasonal basis) to facilitate compliance and provide an opportunity for water quality offsets and trading.

10.3 Conclusions

As nutrient discharge permits become stricter (closer to zero with no margin for variability) the more challenging, expensive, and greater the environmental trade-offs become in pursuit of compliance. For these reasons and others, the traditional deterministic approach to effluent discharge permitting may result in overly restrictive limitations that accomplish little in terms of water quality improvement. More appropriate approaches for nutrients incorporate treatment technology performance statistics, predictive water quality models, and probabilistic approaches that combine technically feasible treatment limits with achievement of water quality objectives. More appropriate nutrients discharge permits may be developed when conditions include the following:

- Collaboration between permit writers and permittees to craft a flexible nutrient permits.
- 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 water requirements.

APPENDIX A

SUMMARY TABULATION OF STATE NUTRIENT CRITERIA AND PERMITS

Table A-1 presents a summary of numeric nutrient criteria rulemaking across the country, along with highlights of select NPDES permits with nutrient limits by state. This table summarizes information from the details in Appendices B and C.

Table A-1. U.S. Nutrient Criteria and Permit Summary.

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
Alabama	N	N	1 mg/L	N	Y	Y	-	-	-	Y	Numeric criteria is for Treasured Alabama Lakes
	Helena Wastewater Treatment Plant, NPDES Permit AL0023116				0.043 mg/L	TKN: 61.9 lb/day, 1.5 mg/L	Monthly Average Weekly Average	Monthly Average Weekly Average	Monthly and Weekly	20.6 lb/day, 0.5 mg/L	10-year compliance schedule with interim limits for TP
Alaska	N	N	N	N	N	N	-	-	-	Y	Most effluent nutrient permits are ammonia
	Palmer Wastewater Treatment Plant, NPDES Permit AK-002249-7				N	N	-	-	-	1.7 mg/L monthly average 3.6 mg/L daily max	Ammonia limits only; seasonal variation in concentration and load limits
Arizona	Y, site-specific	Y, site-specific	0.05-1 mg/L	0.1-3 mg/L	Y	Y	-	-	-	-	-
	Northern Gila County Sanitation District American Gulch Water Reclamation Facility, NPDES Permit AZ0020117				0.1 mg/L and 1.0 mg/L	1.0 mg/L and 3.0 mg/L	Monthly Average Daily Max	-	Monthly	-	NPDES permit includes limitations based on the water quality standards as well as variances above the water quality standards. Variances include annual mean and single sample maximum values
Arkansas	N	N	N	N	Y	N	-	-	-	Y	Arkansas has nitrogen limits of 10 mg/l TN for POTWs discharging in northwestern Arkansas into the Illinois River a tributary that flows into Oklahoma and then into the

State Key Reference Permit	Nutrient Rulemaking: Numeric Nutrient Criteria P	Nutrient Rulemaking: Numeric Nutrient Criteria N	Nutrient Rulemaking: Technology Effluent Limits TP	Nutrient Rulemaking: Technology Effluent Limits TN	NPDES Permitting P	NPDES Permitting N	NPDES Permitting Conc.	NPDES Permitting Mass	NPDES Permitting Averaging	Ammonia Limits	Comments
											Arkansas River
	Berryville Wastewater Treatment Plant, NPDES Permit AR0021792				20.0 lb/day 1 mg/L	-	Monthly Average 7-Day Average	Monthly Average	Monthly and weekly	32-80.1 lb/day 1.6-4.0 mg/L	Ammonia limits vary by season
California	N	N	N	N	-	-	-	-	-	Y	-
	Sacramento Regional County Sanitation District Wastewater Treatment Plant, NPDES Permit CA0077682				N	Ammonia : 1.8 mg/L Nitrate: 10 mg/L	Monthly Average Daily Max	Monthly Average	Monthly	-	-
Colorado	Y	Y	1 mg/L	15 mg/L (TIN)	-	-	-	-	-	-	Control Regulation 85 – establishes numeric effluent limitations Control Regulation 31 – establishes in-stream nutrient values
	Metro Wastewater Reclamation District, NPDES Permit CO-0026638				N	Ammonia : 9.7- 15 mg/L (interim) 2.04-4.64 mg/L (final) Nitrate: 8.68 mg/L	Ammonia : Monthly Average and Daily Max Nitrate: Weekly Average	-	Monthly and Weekly	Y	No NPDES permits that have incorporated Control Regulation 85
Connecticut	N	N	N	N	-	-	-	-	-	-	Nitrogen general permit has nitrogen limits in place for 79 POTWs in Connecticut
	Wallingford Water Pollution Control Facility, NPDES Permit CT06492				0.31 mg/L	N	Weekly average	Average Seasonal Load Cap (8.95 lb/day over the 214 day	Weekly and Seasonal	3.0-9.0 mg/L, monthly average	First permit step was technology based limit; Second permit step allows 9 years for planning, design and construction to meet

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
								season, April through October)			water quality standards based limits
Delaware	N	N	N	N	-	-	-	-	-	-	-
	Bridgeville Wastewater Treatment Plant, NPDES Permit DE0020249				13.4 lb/day 4,909 lb/year	52.9 lb/day 19,312 lb/year	-	Daily average	May through September; twelve month cumulative discharge load	-	NPDES permit that incorporates wasteload allocations from Chesapeake Bay TMDL
Florida	Y	Y	1 mg/L	3 mg/L	-	-	-	-	-	-	-
	County Regional Wastewater Treatment Plant, NPDES Permit FL0028061				1.0 mg/L 1.25 mg/L 2.0 mg/L	3.0 mg/L 3.75 mg/L 6.0 mg/L	Annual Average Monthly Average Single Sample	-	Monthly and weekly average	-	-
Georgia	N	N	N	N	-	-	-	-	-	-	-
	Oquina Creek Water Pollution Control Plant, NPDES Permit GA0024082				N	N	-	-	-	2.0-10.0 mg/L Monthly and weekly averages; vary with seasons	Ammonia limits only at this time
Hawaii	Y	Y	N	N	-	-	-	-	-	-	-
	NAVFAC Hawaii Wastewater Treatment Plant at the Department of Navy Joint Base Pearl Harbor-Hickam, NPDES Permit HI0110086				2.22 mg/L	16.65 mg/L TN 0.39 mg/L ammonia	-	-	Geometric mean of previous 11 months	-	All samples taken and analyzed must be included in the geometric mean calculation
Idaho	N	N	N	N	Y	N	-	-	-	-	-
	Coeur d'Alene Wastewater Treatment Plant, NPDES Permit ID0022853				3.17 lb/day	N	-	Seasonal	Seasonal	272 lb/day	-
Illinois	Y	Y	N	N	Y	Unknown	-	-	-	-	Illinois EPA

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
											Permitting Section did not know whether there were any NPDES permits that included TN limits
	Village of Algonquin Wastewater Treatment Plant, NPDES Permit IL023329				42 lb/day	N	Monthly average	Monthly average	Monthly	Monthly average and daily maximum mass limits that vary by season	-
Indiana	Y	N	1 mg/L	N	Y	N	Monthly average	Monthly and weekly average	-	-	Numeric phosphorus limits are for dischargers within 40 miles of a lake or reservoir in the Great Lakes basin. Numeric nutrient criteria are in draft for lakes
	Westfield Westside Wastewater Treatment Plant, NPDES Permit IN0059544				1 mg/L	-	Monthly average	-	Monthly	32.5-47.6 lb/day with seasonal variation	-
Iowa	Y	Y	Y, estimated as 1 mg/L	Y, estimated as 10 mg/L	Y	Y	-	Annual average	12 month average	-	Iowa Nutrient Reduction Strategy (2012) includes phased requirements for municipal wastewater upgrades; no NPDES permits have limits based on the strategy
	Waterloo Sewage Treatment Plant, NPDES Permit IA0790001				N	9,285.5 lb		Monthly mass	-	Year-round, monthly and weekly	-

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
										limits	
Kansas	Y	Y	1.5 mg/L	10 mg/L	Y	Y	-	-	-	-	Kansas Surface Water Nutrient Reduction Plan (2004) stipulates point source reductions for dischargers greater than 1 mgd
	Dodge City Water Reclamation Facility NPDES Permit KS0099830				Y	Y	Y	Y	Rolling 12 month average	-	-
Kentucky	N	N	N	N	-	-	-	-	-	-	-
	Symsonia Sewer District, NPDES Permit KY0055271				1 mg/L	-	Monthly Average	-	Year-round monthly limits	Monthly and weekly average concentratio n and mass limits with seasonal variations	-
Louisiana	N	N	N	N	-	-	-	-	-	-	-
	-				-	-	-	-	-	-	-
Maine	Draft	Draft	N	N	-	-	-	-	-	-	-
	-				-	-	-	-	-	-	-
Maryland	N	N	N	N	Y	Y	-	-	-	-	-
	Broadwater Water Reclamation Facility, NPDES Permit MN0024350				1,827 lb/year	24,364 lb/year	-	Total annual	-	-	Total annual load for TN and TP based on the wasteload allocations from the Chesapeake Bay TMDL
Massachuset ts	N	N	N	N	Y	Y	-	-	-	-	-
	Upper Blackstone Water Pollution Abatement District, Draft NPDES Permit				0.1 mg/L	5.0 mg/L	Monthly average	-	Monthly average	-	-

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
	MA0102369								from April to October (TP) and May to October (TN)		
Michigan	Y	N	1 mg/L	N	Y	Y	-	-	-	-	Effluent TP limits are based on the Great Lakes Water Quality Agreement which was ultimately updated in the state water quality standards
	Lansing Wastewater Treatment Plant, NPDES Permit MI0023400				1 mg/L 290 lb/day	-	Monthly Average	Monthly Average	Monthly Average	-	-
Minnesota	Y	N	N	N	Y	Y	Y	Y		-	-
	Metropolitan Council – Metropolitan Wastewater Treatment Plant, NPDES Permit MN0029815				1 mg/L	431,077 kg/yr	12-month moving average	12 month total	12 month moving average	-	-
Mississippi	N	N	N	N	-	-	-	-	-	-	-
	Jackson Publically Owned Treatment Works, NPDES Permit MS0024295				1,180 lb/day	5,221 lb/day	--	Monthly and weekly average	Monthly and weekly average mass limits	-	-
Missouri	N	N	N	N	Y	Y	-	-	-	-	-
	Springfield Southwest Wastewater Treatment Plant, NDPES Permit MO0049522				0.5 mg/L	N	Monthly average	-	Year-round, monthly average	Monthly and weekly average	-
Montana	Y	Y	1 mg/L	10 mg/L	Y	Y	Y	Y	-	-	-
	City of Kalispell Wastewater Treatment Plant, NPDES Permit MT0021938				1.0 mg/L 25.8 lb/day	268 lb/day	Monthly average for TP	Monthly average for TP and TN	Monthly average	2.16 mg/L, winter 1.23 mg/L, summer	-
Nebraska	Y	Y	N	N	-	-	-	-	-	-	-
	Hastings Pollution Control Facility, NPDES Permit NE0038946				N	N	-	-	-	8.1-8.7 mg/L 119.4-128.3 kg/day,	Ammonia limits only

State	Nutrient Rulemaking				NPDES Permitting						
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	Comments
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
										with seasonal variations	
Nevada	N	N	N	N	Y	Y	Y	Y	-	-	-
	Truckee Meadows Water Reclamation Facility, NPDES Permit NV0020150				0.40 mg/L 134 lb/day	500 lb/day	Monthly average	Monthly average	Year-round, monthly average	-	-
New Hampshire	N	N	N	N	-	-	-	-	-	-	- Great Bay TMDL includes limits for nitrogen and phosphorus from Wasteload Allocation for POTWs discharging to Great Bay
	Concord Wastewater Treatment Plant, NPDES Permit NH0100901				199 lb/day	-	-	Monthly average	April through October, monthly average	-	-
New Jersey	Y	N	1 mg/L	N	-	-	-	-	-	-	-
	Allamuchy Sewerage Treatment Plant, NPDES Permit NJ0020605				1.19 mg/L 1.11 kg/day		Monthly and weekly average	Monthly and Weekly average	Year-round, summer, and winter TP limits for concentratio n and mass averaged on a monthly and weekly basis	Summer and winter ammonia limits for concentratio n and mass averaged on a monthly and weekly basis	-
New Mexico	Y	Y	N	N	-	-	-	-	-	-	-
	City of Ruidoso Downs and Village of Ruidoso Wastewater Treatment Plant, NPDES Permit NM0029165				0.1-0.15 mg/L 2.16 lb/day	1-6 mg/L 18.9-90.1 lb/day	Average monthly and daily max	Average monthly and daily max	Year-round average monthly and daily max limits	-	TN limits vary with temperature
New York	Y	Y	N	N	-	-	-	-	-	-	Water-body specific

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	**Numeric Nutrient Criteria**		**Technology Effluent Limits**							**Ammonia Limits**	
	P	**N**	**TP**	**TN**	**P**	**N**	**Conc.**	**Mass**	**Averaging**		
											nutrient criteria are included in the state water quality standards. Nitrogen limits for New York POTWs discharging to Long Island Sound, Jamaica Bay, and Chesapeake Bay watersheds.
	Onondaga County Department of Water Environment Protection, NPDES Permit NY0027081				Interim: 0.10 mg/L Final: 0.02 mg/L	-	12-month rolling average	-	12-month rolling average	-	TMDL for Onondaga Lake requires final TP for Outfall 001 to be 0.1 mg/L and includes a bubble annual mass loading limit of 27,212 lb/year for Outfalls 001 and 002 combined, both on a 12-month rolling average basis
North Carolina	N	N	N	N	Y	Y	-	-	-	-	-
	Greenville Utilities Commission				The GUC WWTP NPDES permit requires the utility to participate in the Tar-Pamlico Basin Association and the permit states that the TN and TP limits are subject to Tar-Pamlico Nutrient Sensitive Water Implementation Strategy. The implementation strategy was developed in lieu of permit limits and requires the 15 member facilities to meet the combined annual mass loading limits. The total combined permitted flow of 62.35 mgd, include 891,272 lb/year total nitrogen and 161,070 lb/year total phosphorus					-	-
North Dakota	N	N	N	N	N	N	-	-	-	-	-
	City of Wahpeton Wastewater Treatment Plant, NPDES Permit ND0020320				N	N	-	-	-	2.38 mg/L average	Ammonia limits only

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
										monthly 5.83 mg/L maximum daily	
Ohio	Y	N	1 mg/L	N	Y	-	-	-	-	-	-
	Easterly Wastewater Treatment Plant, NPDES Permit OH0024643				1 mg/L 587 kg/day	-	Monthly average and daily maximum	Monthly average and daily maximum	Year-round, average monthly limits	-	-
Oklahoma	Y	Y	N	N	-	-	-	-	-	-	-
	Westville Utility Authority, NPDES Permit OK0028126				2.34 lb/day 1 mg/L	-	Monthly and weekly average	Monthly average	-	Monthly average concentration and mass limits with seasonal variation	-
Oregon	Y	N	N	N	-	-	-	-	-	-	-
	Clean Water Services, Durham AWTF NPDES Permit OR141142				0.11 mg/L	-	Monthly median	-	Monthly median	Seasonal ammonia removal, weekly median ammonia load limits	-
Pennsylvania	N	N	N	N	Y	Y	-	-	-	-	-
	Mid Cameron Municipal Authority, NPDES Permit PA0028631				2,140 lb/year	17,100 lb/year	-	Equivalent to 5.6 mg/L TN and 0.7 mg/L TP at 1 mgd	-	-	Nitrogen and phosphorus limits based on the wasteload allocation assigned to the Authority's treatment plant in the Chesapeake Bay TMDL
Rhode Island	Y	Y	N	N	-	-	-	-	-	-	- The Rhode Island Narragansett Bay

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
											nutrient program targets total nitrogen limits that range from 5.0 to 8.0 mg/l
	East Greenwich Wastewater Treatment Facility, NPDES Permit RI0100030				N	5 mg/L 71 lb/day	Average monthly	Average monthly	Average monthly	-	-
South Carolina	Y	Y	N	N	-	-	-	-	-	-	-
	-				-	-	-	-	-	-	-
South Dakota	N	N	N	N	-	-	-	-	-	-	-
	City of Wagner Wastewater Treatment Plant, NPDES Permit SD0020184				N	N	N	N	-	Monthly average and daily maximum limits that vary each month.	Ammonia limits only
Tennessee	N	N	N	N	Y	Y	-	-	-	-	-
	Cookeville Wastewater Treatment Plant, NPDES Permit TN0024198				245 lb/day	1,532 lb/day	-	Daily average	Calendar year average of the daily loads	-	-
Texas	N	N	N	N	-	-	-	-	-	-	-
	City of Burnet Wastewater Treatment Facility, NPDES Permit WQ0010793002				0.5 mg/L daily average 1 mg/L 7-day average 2 mg/L Daily Maximum 3 mg/L single grab	6 mg/L daily average 7.1 lb/day daily average	Daily average, 7-day average, daily maximum, single grab	Daily average	Daily average is the average of all effluent samples within one calendar month	Daily average conc. and load, 7-day average concentration, daily maximum, and single grab limits	-
Utah	N	N	N	N	Y	-	-		-		-
	East Canyon Creek Water Reclamation Facility, NPDES Permit UT0020001				322 lb/season 1,969 lb/year	N	-	Seasonal load:	-	Max month and daily	-

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
								July, August, Septembe r		max con-centration and max month load	
Vermont	N	Y	N	N	Y	-	-	-	-	-	-
	Montpelier Wastewater Treatment Facility, NPDES Permit VT0100196				0.8 mg/L 7,253 lb	N	Monthly average	Annual	-	-	-
Virginia	N	N	N	N	Y	Y	-	-	-	-	-
	Hampton Roads Sanitation District, NPDES Permit VA0081281				2 mg/L	-	-	-	-	-	The General Permit ( ) States that the 39 significant dischargers in the James River Basin shall meet aggregate discharged waste load allocations of 8,968,864 lbs/yr TN and 545,558 lbs/yr TP by January 1, 2023
Washington	Y	N	N	N	-	-	-	-	-	-	Nutrient criteria for lakes
	Spokane County Regional Water Reclamation Facility, NPDES Permit WA0093317				2.80 lb/day	N	-	Seasonal load, March through October	Seasonal	Seasonal load and maximum daily limits	-
West Virginia	Y	N	N	N	-	-	-	-	-	-	-
Wisconsin	Y	N	Y	N	0.6 mg/L- 1st permit 0.5 mg/L – 2nd permit	-	-	-	varies	-	-
	Little Suamico Sanitary District No. 1, NPDES Permit WI0031968-06-0				-	-	-	-	-	-	The interim effluent limitation for phosphorus will be determined after the

State	Nutrient Rulemaking				NPDES Permitting						Comments
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
											first 12 months of effluent monitoring has been completed. The limitation shall equal the upper 99th percentile of representative daily discharge concentrations (one−day P99)
Wyoming	N	N	N	N	N	N	N	N	-	-	-
	Sheridan Wastewater Treatment Plant, Permit Number WY0020010				N	N	N	N	-	Average monthly and daily maximum	Ammonia limits only

A.1 Nutrient Regulations in Canada

Nutrient regulations in Canada include both federal and provincial rules. The Wastewater System Effluent Regulations (WSER) are national standards for wastewater treatment that are issued and regulated by the Ministry of the Environment under the Fisheries Act. These standards require that wastewater treatment plants achieve secondary treatment prior to discharge. There are minimum effluent requirements depending on the size of the facility that include CBOD, TSS, and un-ionized ammonia. There is a phased implementation of these regulations. Wastewater systems posing a high risk to water quality are required to meet the effluent quality standards by 2020, medium risk by 2030, and low risk by 2040. In addition to the national regulations, each province can set provincial WQS.

The Canadian Council of Ministers of the Environment (CCME) is "the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern." CCME is comprised of the 14 Canadian Minsters of the Environment and includes a variety of committees and task forces. In 2009, CCME developed the Canada-wide Strategy for the Management of Municipal Wastewater Effluent. The strategy requires that wastewater treatment facilities achieve the minimum National Performance Standards, which are common to most wastewater discharges.

Discharge permits, or authorizations, specify the effluent water quality limits for wastewater treatment plants. The effluent nutrient limits are typical monthly average concentration and load limits. Weekly limits may be set depending on the water quality objectives and the technology in place. The permit structure is not standardized and is determined by the Department of Environment in each individual province.

A.2 Provincial Discharge Permit Requirements

The following discussions highlight receiving water quality criteria and effluent nutrient limits in British Columbia, Manitoba, and Ontario. Table 1 presents a summary of provincial nutrient standards and an example municipal wastewater discharge permit from each province.

A.3 British Columbia

British Columbia does not have provincial-wide numeric nutrient criteria, however there are water quality criteria based on water use. For lakes that serve as drinking water sources, the TP criterion is a maximum of 10 ug/L. For lakes than are used for recreation, or to support aquatic life, the TP criteria is10 ug/L. Streams that support aquatic life and recreation have chlorophyll-a criteria of 100 mg/m^2 and 50 mg/m^2, respectively. Effluent nutrient criteria are set based on site-specific conditions. Due to the pristine nature of the natural lakes, the resulting effluent nutrient discharge limits are some of the lowest in North America due to the receiving water criteria (lakes). The provincial wastewater regulations restrict total annual average phosphorus discharges to less than 0.25 mg/L for the following waterbodies:

- Okanagan Basin.
- Christina Lake Basin.
- Thompson River at Kamloops.
- Cowichan River.

- Nicola River at Merritt.
- Cheakamus River at Whistler.

A.4 Manitoba

In Manitoba, there are two pieces of legislation that drive nutrient limits in wastewater discharge licenses. The Environment Act requires a license for wastewater plant operation. The license defines treatment plants effluent limits. The Water Protection Act includes WQS, objectives and guidelines, including those for nutrients. Minimum requirements for treatment in Manitoba are included in the Water Protection Act. Licenses may include limits based on site-specific information that are more stringent than the Water Protection Act. The minimum TP requirement for a municipal wastewater discharge is 1 mg/L as a 30-day rolling average. TN is also permitted as a 30-day rolling average. Ammonia limits can be incorporated as loads, or concentrations, and the averaging period varies depending on the water body. Site specific effluent requirements can be developed and may be stricter.

A.5 Ontario

The province of Ontario requires Certificates of Approval through the Ministry of Environment and Climate Change. Generally, treatment plants must achieve secondary treatment. Supplemental effluent requirements are determined on a site-specific basis with consideration for receiving water quality. Additionally, a phosphorus removal program was adopted in Ontario in the 1970s. In 1983, the Supplementary Agreement to the 1978 Canada-United States Agreement on Great Lakes Water Quality was signed requiring effluent TP concentrations of 1 mg/L on a monthly average basis at treatment plants greater than 1 mgd in the Upper Lakes Basin (Ontario, 2014).

Table A-2. Summary of Nutrient Criteria and Effluent Limits for Select Canadian Provinces.

Province	Nutrient Rulemaking				NPDES Permitting						
Key Reference Permit	Numeric Nutrient Criteria		Technology Effluent Limits							Ammonia Limits	Comments
	P	N	TP	TN	P	N	Conc.	Mass	Averaging		
British Columbia	N	N	N	N	Y	Y	-	-	-	Y	-
Kelowna Wastewater Treatment Plant, Permit PE 01434					0.25 mg/L ave 2.0 mg/L max	6.0 mg/L ave, 10 mg/L max	Annual average, daily maximum	Total annual discharge (tonnes)	Monthly and annual	-	Numeric criteria is for Okanagan Lake to meet background concentration level
Manitoba	Y	Y	N	N	N	N	-	-	-	Y	-
City of Brandon Centralized Wastewater Treatment Facility Environmental Act License No. 2991					1 mg/L	15 mg/L	Average	-	30-day rolling	Daily mass limit, varies by month	Ammonia limits only; seasonal variation in concentration and load limits
Ontario	Y	N	N	N	-	-	-	-	-	-	-
City of Toronto Ashbridges Bay Treatment Plant Environmental Compliance Approval 2251-8Y8KRT					1 mg/L 818 kg/day	-	Average	Average	-	-	Great Lakes water quality requirements

APPENDIX B

SUMMARY OF STATE NUTRIENT CRITERIA

The purpose of this appendix is to provide a reference source on the status of individual state's nutrient criteria. In particular, where numeric nutrient criteria rulemaking has been undertaken or is in progress has been highlighted. Numeric nutrient criteria link directly to NPDES discharge permitting because permit writers must conduct a reasonable potential analysis using the criteria to determine whether or not effluent limits for nitrogen and/or phosphorus are required. Numeric nutrient criteria are commonly low concentrations of nitrogen and phosphorus and ambient receiving water concentrations may exceed these criteria. Consequently, the existence of state numeric nutrient criteria alone may result in effluent limits even if a TMDL or other watershed study targeting nutrient reduction has not been completed.

In some instances, states have elected not to pursue development of numeric nutrient criteria, or have chosen to pursue alternative approaches to nutrient management. This may link directly to nutrient permitting when technology based effluent limits are selected by a state to achieve an initial level of point source nutrient reduction. Some states have chosen to develop a combination approach using both stressors (nitrogen, P) and response variables (pH, DO, chlorophyll-a, algae density, biological indices) in the formulation of nutrient criteria.

B.1 Introduction

In a memorandum to Directors of State Water Programs, Directors of Great Water Body Programs, Directors of Authorized Tribal WQS Programs, and State and Interstate Water Pollution Control Administrators on May 25, 2007, the U.S. EPA encouraged States, Territories and Tribes to accelerate the adoption of numeric nutrient standards or numeric translators for narrative standards for waters that contribute nutrient loadings (EPA, 2007). EPA suggested both causal (nitrogen and phosphorus) and response (chlorophyll-a and transparency) variables for all waterways.

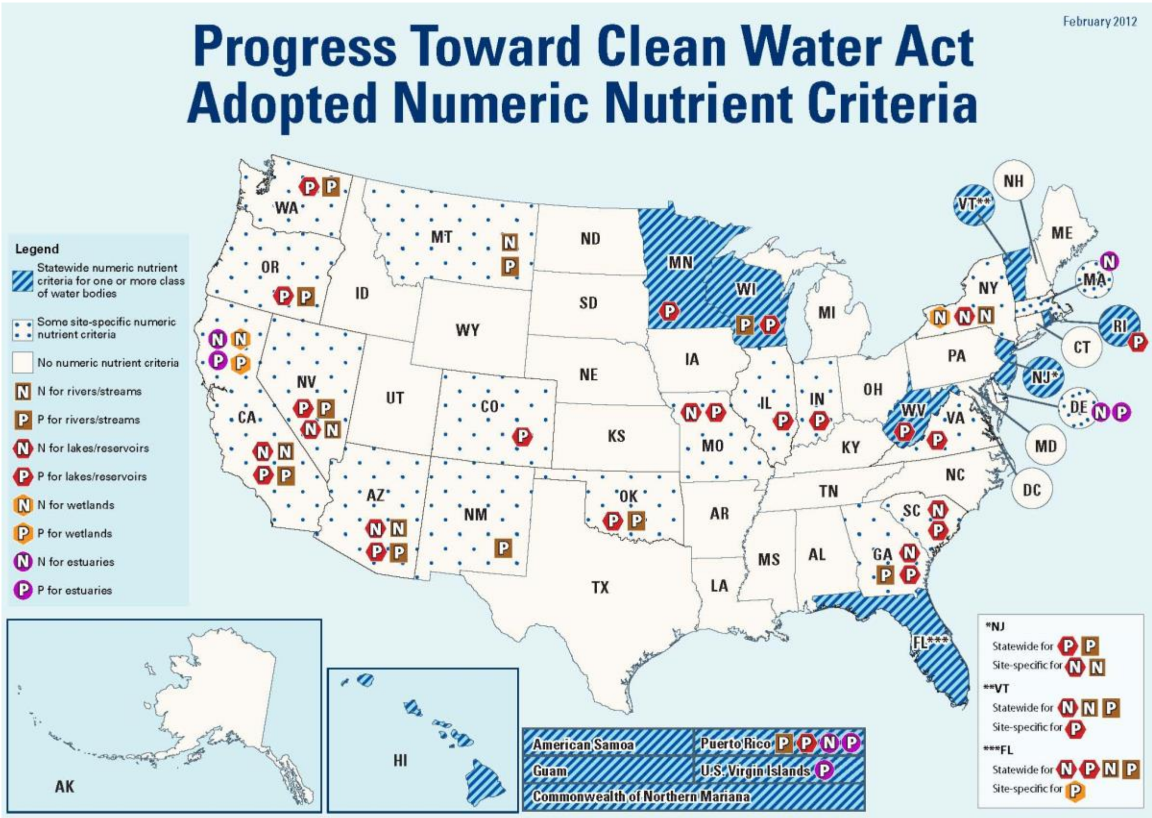

Figure B-1. Statewide and Site Specific Nutrient Criteria.
(EPA, 2012b).

Alabama, Arkansas, Iowa, Kansas, Kentucky, Missouri, Nebraska, North Dakota, Oklahoma, and South Dakota filed a motion in U.S. District Court to intervene in a federal lawsuit in which several environmental advocacy groups are calling for EPA to establish and enforce numeric criteria standards for the entire Mississippi River watershed.

B.2 Alabama

Historically, numeric nitrogen and phosphorus limits have been incorporated into NPDES permits through TMDLs in Alabama. Recently, chlorophyll-a WQS for large reservoirs were developed and included in the Alabama Department of Environmental Management Administrative Code (Alabama DEM, 2012). Statewide river and stream nutrient criteria will likely be ecoregion specific, based on the state's implementation plan (Alabama DEM, 2010).

The Alabama WQS require that new wastewater treatment plants or major modifications to existing wastewater treatment plants that discharge to Treasured Alabama Lakes must meet a monthly average effluent limitation of 1.0 mg/L TP.

Nutrient limits in NPDES permits have been implemented on a site-specific basis through TMDLs. The Cahaba River has a numeric nutrient target TP concentration of 0.035 mg/L (Alabama DEM, 2010). Discharge permits on the Cahaba River have growing season (April through October) effluent phosphorus concentration limits of 0.043 mg/L. An example of the permit structure for effluent phosphorus limits shows a ten year compliance schedule to meet growing season monthly average phosphorus limits of 0.043 mg/L (Figure B-2).

(TP) From the permit effective date through August 31, 2014 – Growing season monthly average limit = 1.8 mg/l
From September 1, 2014 through March 31, 2022 – Growing season monthly average limit = 0.2 mg/l
From April 1, 2022 forward – Growing season monthly average limit = 0.043 mg/l
For complete schedule, see Part I.E.2

Figure B-2. Alabaster WWTP NPDES Permit (Alabama DEM, 2010), Phosphorus Limits and Compliance Schedule.

B.3 Alaska

The state of Alaska WQS include narrative criterion for the May 2003 WQS (18 AAC 70) – "There may be no concentrations of toxic substances in water or in shoreline or bottom sediments that in singly or in combination cause or reasonably can be expected to cause adverse effects on aquatic life or produce undesirable or nuisance aquatic life, except as authorized in this chapter."

The state has not initiated the development of statewide nutrient criteria. The nutrient limits that are currently in NPDES discharge permits are for facilities that discharge to anadromous streams. Anadromous streams are those that support migratory fish that migrate between sea and fresh water. Anadromous fish live in sea water and breed in fresh water, typical of salmon streams in Alaska. There are currently no facilities with TP limits. The state intends to avoid a singular statewide approach because of the inherent differences in Alaska's waterbodies (ACWA, 2012).

B.4 Arizona

The Arizona WQS (Arizona Administrative Code, Title 18 Chapter 11) include narrative and numeric nutrient criteria. The narrative lake criteria are met when the average chlorophyll-a values are below the threshold for the designated use and lake category. Table B-1 summarizes the numeric water quality targets for lakes and reservoirs.

Table B-1. Arizona Water Quality Standards – Numeric Targets for Lakes and Reservoirs.

Designated Use	Lake Category	Chl-*a* (µg/L)	Secchi Depth (m)	Blue-Green Algae (per mL)	Blue-Green Algae (% of total count)	Tot. Phos. (mg/L)	Tot. Nit. (mg/L)	TKN (mg/L)	Dissolved Oxygen (mg/L)	pH (SU)
FBC	Deep	10-15	1.5-2.5	20,000	NA	70-90	1.2-1.4	1.0-1.1	NA	6.5 – 9.0
	Shallow	10-15	1.5-2.0		NA	70-90	1.2-1.4	1.0-1.1	NA	
	Igneous	20-30	0.5-1.0		NA	100-125	1.5-1.7	1.2-1.4	NA	
	Sedimentary	20-30	1.5-2.0		NA	100-125	1.5-1.7	1.2-1.4	NA	
	Urban	20-30	0.5-1.0		NA	100-125	1.5-1.7	1.2-1.4	NA	
A&Wc	All	5-15	1.5-2.0	NA	<50	50-90	1.0-1.4	0.7-1.1	7 (top m)	6.5 – 9.0
A&Ww	All (except urban lakes)	25-40	0.8-1.0	NA		115-140	1.6-1.8	1.3-1.6	6 (top m)	
	Urban	30-50	0.7-1.0	NA		125-160	1.7-1.9	1.4-1.7		
A&W/edw	All	30-50	0.7-1.0	NA		125-160	1.7-1.9	1.4-1.7		6.0-6.5
DWS	All	10-20	0.5-1.5	20,000	NA	70-100	1.2-1.5	1.0-1.2	NA	5.0 – 9.0

Narrative Nutrient Standard Implementation Procedures for Lakes and Reservoirs describes how the narrative criteria will be implemented in the state (Arizona DEQ, 2008). The water quality criteria require no excess algal and plant growth. Arizona DEQ will determine compliance in one of the following four ways:

- ♦ Mean chlorophyll-a results are at or above the upper value in the target range for chi-a for the lake category.
- ♦ Mean chi-a result is within the target range for chi-a for the lake and the mean blue-green algae result is at or below 20,000/mL or the mean blue-green algae count is 50% or less of the total algae count.
- ♦ The mean chlorophyll-a result is within the prescribed range for the lake category and there is no evidence of nutrient impairment such as:
    - o Exceedance of DO or pH standard.
    - o Fish kills or other aquatic organism mortality attributed to exceedances of DO, pH or ammonia or algal toxicity.
    - o Sechhi depth below lower threshold.
    - o Concentration of TP, TN, or TKN exceed upper value in range for lake category.
- ♦ For a shallow lake with mean depth less than 4 meters and submerged aquatic vegetation covers more than 50 percent of the aerial extent of the lake bottom and there is a greater than 5 mg/L swing in diel DO in photic zone.

The numeric lake nutrient standards have not been approved by EPA. The state of Arizona is currently updating the data and providing more information to EPA to see if any changes to the criteria are necessary. Arizona is considering a five year plan to revisit nutrient criteria for rivers and streams. The current challenge is applying standards for all of the tributaries of a receiving water body.

Arizona developed and adopted numeric nutrient criteria for specific waterbodies. The WQS include annual mean, 90^{th} percentile, and single sample maximum TP and TN concentrations. A minimum of 10 samples taken at least 10 days apart in a consecutive 12-month period are required to determine the 90th percentile. Table B-2 summarizes the WQS for individual waterbodies.

Table B-2. Arizona Water Quality Standards for Specific Waterbodies.

	Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
1.	**Verde River and its tributaries from the Verde headwaters to Bartlett Lake**			
	Total Phosphorus	0.10	0.30	1.00
	Total Nitrogen	1.00	1.50	3.00
2.	**Black River, Tonto Creek and their tributaries that are not located on tribal lands**			
	Total Phosphorus	0.10	0.20	0.80
	Total Nitrogen	0.50	1.00	2.00
3.	**Salt River and its tributaries above Roosevelt Reservoir, excluding Pinal Creek, that are not located on tribal lands**			
	Total Phosphorus	0.12	0.30	1.00
	Total Nitrogen	0.60	1.20	2.00
4.	**Salt River below Stewart Mountain Dam to its confluence with the Verde River**			
	Total Phosphorus	0.05		0.20
	Total Nitrogen	0.60		3.00
5.	**Little Colorado River and its tributaries above River Reservoir in Greer; South Fork of Little Colorado River above South Fork Campground; and Water Canyon Creek above Apache-Sitegraves National Forest Boundary**			
	Total Phosphorus	0.08	0.10	0.75
	Total Nitrogen	0.60	0.75	1.10
6.	**Little Colorado River at the crossing of Apache County Road No. 124**			
	Total Phosphorus			0.75
	Total Nitrogen			1.80
7.	**Little Colorado River above Lyman Lake to above the Amity Ditch diversion near crossing of Arizona Highway 273 (applies only when in-stream turbidity is less than 50 NTU)**			
	Total Phosphorus	0.20	0.30	0.75
	Total Nitrogen	0.70	1.20	1.50
8.	**Colorado River at the Northern International Boundary near Morelos Dam**			
	Total Phosphorus		0.33	
	Total Nitrogen		2.50	
9.	**Oak Creek from its headwaters to its confluence with the Verde River and the West Fork of Oak Creek from its headwaters to its confluence with Oak Creek.**			
	Total Phosphorus	1.00	1.50	2.50
	Total Nitrogen	0.10	0.25	0.30
10.	**No discharge of wastewater to Show Low Creek or its tributaries upstream of and including Fools Hollow Lake shall exceed 0.16 mg/L total phosphates as P.**			
11.	**No discharge of wastewater to the San Francisco River or its tributaries upstream of Luna Lake Dam shall exceed 1.0 mg/L total phosphates as P.**			

Most NPDES permits include variances to meet the water quality criteria in Arizona. Generally the NPDES permits include both concentration and load effluent limitations for phosphorus that are applied year round. Arizona applies an annual mean or 90th percentile limitation rather than a monthly or weekly average.

B.5 Arkansas

The current Arkansas WQS include narrative nutrient criteria based on limiting algal growth that impairs the designated use of the waterbody. Nutrients are managed through TMDLs and NPDES permitting. The state of Arkansas is in the process of developing standard methods to establish numeric nutrient criteria for streams and rivers (Arkansas DEQ, 2012).

B.6 California

California regulates water quality through 9 regional water quality control boards (WQCB) which maintain Basin Plans. The Basin Plans designate beneficial use for waterbodies and develop WQS for each water body in the Regional jurisdiction. Each Region is responsible for developing, issuing, and regulating NPDES permits. The State Water Resources Control Board (SWRCB) provides assistance to the regional boards. TMDLs are established through regulatory actions to improve the water quality of impaired waterways.

In 2006 the SWRCB issued the Technical Approach to Develop Nutrient Numeric Endpoints for California. This document serves as a guideline for setting numeric nutrient limits for NPDES permits, developing TMDLs, numeric nutrient endpoints and numeric nutrient NN criteria. This report defines three beneficial user classification categories, which are summarized below:

- **BURC I:** This category includes waterbodies in which beneficial uses are sustained and impairment due to nutrients is not exhibited.
- **BURC II**: This category includes waterbodies in which beneficial uses may be impaired; however, additional information and analysis may be needed to determine the extent of impairment and whether regulatory action is warranted.
- **BURC III:** This category includes waterbodies in which impairment due to nutrients is clearly exhibited and regulatory action warranted.

The state uses modeling tools to complete a linkage analysis between secondary indicators and water column nutrient concentrations.

In 2008, the SWRCB adopted a statewide policy for compliance schedules of NPDES permits and consistency in implementation. Regional water boards are allowed to include compliance schedules in the NPDES permits. Additional in 2011 the SWRCB began the process of scoping a nutrient policy.

B.7 Colorado

The EPA has been working with states to reduce nutrient levels. The emphasis being placed on developing numeric nutrient criteria is specifically tied to the control of "nitrogen and phosphorus pollution". The intent of numeric nutrient criteria is to ensure a level of water quality that will protect the beneficial uses of these waterbodies. The presence of nitrogen and phosphorus in surface waters leads to a phenomenon referred to as eutrophication. Eutrophication is characterized by an abundant accumulation of nutrients that support a dense growth of algae and other organisms, the decay of which depletes the shallow waters of oxygen. Nitrogen and phosphorus criteria are set so that they protect streams from the impacts of eutrophication, which include both nuisance algae growth and reduced DO levels which impact fish and aquatic life.

In 2001, EPA published eco-regional criteria which provide recommendations to States for use in establishing their WQS consistent with section 303(c) of the CWA. The western forested mountains of Colorado fall under Eco-Region II (http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/rivers_4.pdf). Table B-3 provides a summary of the limits for TN and P developed by EPA for the Eco-regions.

Table B-3. EPA Eco-region Criteria for Rivers and Streams (Source: EPA Ambient Water Quality Criteria Recommendations, December 2001).

Eco-region	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
I: Willamette and Central Valley	0.66	0.055
II: Western Forested Mountains	***0.12***	***0.010***
III: Xeric West	0.38	0.022
IV: Great Plains Grass and Shrublands	0.56	0.023
V: South Central Cultivated Great Plains	0.88	0.067
VI: Corn Belt and Northern Great Plains	2.18	0.076
VII: Mostly Glaciated Dairy Region	0.54	0.033
VIII: Nutrient Poor, Largely Glaciated Upper Midwest and Northeast	0.38	0.010
IX: Southeastern Temperature Forested Plains and Hills	0.69	0.037
X: Texas-Louisiana Coastal and Mississippi Alluvial Plains	0.57	0.060
XI: The Central and Eastern Forested Uplands	0.31	0.010
XII: Southeastern Coastal Plain	0.90	0.040
XIII: Southern Florida Coastal Plain	1.14	0.015
XIV: Eastern Coastal Plain	0.71	0.031

The Colorado Department of Public Health and Environment (CDPHE) chose to develop its own nutrient quality rules, which were adopted by the Water Quality Control Commission (WQCC) in 2012. The State adopted a phased approach to establishing numeric nutrient standards throughout Colorado. These regulations set TP and TIN permit limits for the largest wastewater dischargers and set phosphorus and nitrogen interim values for both lakes and reservoirs and rivers and streams.

The first phase is implementation of CDPHE Regulation 85 (Regulation 85), which set interim effluent standards for TP and total inorganic nitrogen (TIN) of 1.0 mg-P/L of TP and 15 mg-N/L, respectively. Regulation 85 sets permit limits for new dischargers and existing dischargers (excluding existing dischargers ≤2 MGD). The permit limits will be incorporated into permits at the next renewal and compliance schedules will be used to allow the permittee time to come into compliance with these limits.

The second phase of the state’s roll-out of nutrient quality criteria is implementation of Regulation 31. This regulation sets interim annual median in-stream nutrient quality values, and the rule was approved with the presumption that these values would not be established as definitive water quality criteria until 2022 except in very limited cases. The in-stream TP and TN values for warm water streams are 0.17 mg-P/L and 2.01 mg-N/L, respectively.

For ease of reference, Table B-4 summarizes the regulatory requirements of Regulation 85 and 31.

Table B-4. Nutrient-Related Effluent Standards (Regulation 85) and In-Stream Nutrient Values (Regulation 31).

Parameter	Regulation 85 (Effluent Standards)	Regulation 31 (Warm Water In-Stream Values)	Regulation 31 (Cold Water In-Stream Values)
TP (mg-P/L)	1	0.17	0.11
TIN (mg-N/L)	15	N/A	N/A
TN (mg-N/L)	N/A	2.01	1.25
Attached Algae Chlorophyll *a*, milligrams per square meter (mg/m^2)	N/A	150	150

One advantage to Colorado's phased approach to implementing nutrient rules is that it provides time for both water quality assessment and treatment technology initiatives to be developed, proven, and rolled out into the marketplace.

B.8 Connecticut

In 2011, the Connecticut Department of Energy and Environmental Protection (DEEP) removed the 2009 proposed revisions to the WQS that included nutrient criteria and an implementation policy. The 2011 WQS were revised to include updated narrative nutrient criteria that 'better reflect the intent to protect and maintain designated uses for surface waters from the effects of anthropogenic inputs of nutrients" (Connecticut DEEP, 2010). Nitrogen is typically managed through site specific TMDLs. The phosphorus reduction strategy developed and implemented in Connecticut includes biologically based numeric criteria for phosphorus in freshwater streams.

NPDES permits that are issued in Connecticut are based on the Connecticut-specific science that was approved by EPA. This process, including the implementation and water quality improvement, is being monitored and evaluated by EPA. The Connecticut method includes determining if a body of water has a major ecological change, which can be identified as a major change in algal community often linked with high phosphorus loading.

Several new permits issued in Connecticut include a compliance schedule and long-term monitoring as compliance strategies. The NPDES permits for these dischargers include a near-term technology based monthly average and seasonal effluent limit of 0.7 mg/L and a nine year compliance schedule to achieve the WQS based limits, which were established around a long-term average effluent concentration of 0.2 mg/L.

On January 2, 2002, pursuant to Public Act 01-180, the Department issued the General Permit for Nitrogen Discharges (also known as the Nitrogen General Permit) (Connecticut DEEP, 2010). The Nitrogen General Permit was reissued with revised discharge limits consistent with the Long Island Sound TMDL on December 21, 2005; again in 2010; and recently renewed effective January 1, 2016. The current General Permit for Nitrogen Discharges for POTW's continues with the same permit limits as listed in the General Permit for the year 2014. These facilities, in aggregate, must continue to achieve a reduction in the annual loading of total nitrogen to Long Island Sound by approximately 64-percent from the original baseline TMDL in order to continue to meet the target 2014 waste load allocation.

B.9 Delaware

The state of Delaware has not developed statewide numeric nutrient criteria. Currently, all of the nutrient limits that are included in NPDES permits are the results of TMDLs, which have been completed for most waterbodies in the state (ACWA, 2012). Some of the TMDLs are issued by the state and some are issued by EPA.

Issues related to nutrients and permitting are coordinated through several jurisdictions in Delaware including the Delaware River Basin Commission, Delaware, New Jersey, Pennsylvania, New York, EPA Region 2, and EPA Region 3. The variety of entities complicates criteria development and nutrient permitting. While there are no statewide nutrient criteria yet, the Delaware River Basin Commission (which predates the NPDES program) has requested that discharge facilities begin monitoring for nutrients (Personal Communication, January 9, 2013).

The Nanticoke River is the only river in Delaware that flows into the Chesapeake Bay. As such, the Nanticoke River received an allocation for phosphorus and nitrogen in the Chesapeake Bay TMDL and the point source dischargers received waste load allocations as part of that TMDL development. The details of the Delaware component of the Chesapeake TMDL and the Delaware Watershed Implementation Plan are presented in later in this document.

The NPDES permits for the Chesapeake Bay dischargers include daily average TP and TN load limits. The daily average is calculated as the total pounds discharged during a calendar month divided by the total calendar days in a calendar month.

B-10 Florida

The Grizzle-Figg Act (Section 373.4592(4)(f)) was a regulation passed in Florida in the 1970’s in an effort to clean up Tampa Bay. The Act required secondary treatment and “advanced waste treatment” before construction of wastewater treatment facilities was approved. The Grizzle-Figg Act defined “advanced waste treatment” as:

- ♦ CBOD5 = 5 mg/L.
- ♦ TSS = 5 mg/L.
- ♦ TN, as N = 3 mg/L.
- ♦ TP, as P = 1 mg/L.

On January 26, 2010, EPA proposed WQS for lakes and flowing waters in the state of Florida. The EPA summarizes the proposed rule as follows:

The EPA is proposing numeric nutrient water quality criteria to protect aquatic life in lakes and flowing waters, including canals, within the State of Florida and proposing regulations to establish a framework for Florida to develop ‘‘restoration standards’’ for impaired waters. On January 14, 2009, EPA made a determination under section 303(c)(4)(B) of the CWA that numeric nutrient water quality criteria for lakes and flowing waters and for estuaries and coastal waters are necessary for the State of Florida to meet the requirements of CWA section 303(c). Section 303(c)(4) of the CWA requires the Administrator to promptly prepare and publish proposed regulations setting forth new or revised WQS when the

Administrator, or an authorized delegate of the Administrator, determines that such new or revised WQS are necessary to meet requirements of the Act. This proposed rule fulfills EPA's obligation under section 303(c)(4) of the CWA to promptly propose criteria for Florida's lakes and flowing waters.

EPA is proposing four water body types for the State of Florida upon which to base nutrient standards: lakes, streams, springs and clear streams, and canals in south Florida. EPA's proposed rule includes nutrient criteria for both in-stream protection values and downstream protection values (EPA, 2010). The proposed rule would:

- ♦ Set TN and TP limits for the protection of lakes, streams, and canals (in-stream protection values).
- ♦ Set a second set of limits for TN and TP for waters that flow into lakes and estuaries to ensure protection of those downstream waters (downstream protection values or DPVs).

The more stringent of the two criteria would apply for each water body. More stringent criteria in an upstream water body are intended to protect aquatic life in the downstream water body such lakes and estuaries. Based on the data, the DPV will likely be lower than the in-stream protection value for many streams in Florida (FWEA, 2010).

For rivers and streams in Florida, EPA has proposed in-stream protection values as numeric nutrient criteria based on four watershed regions described in Table B-5.

Table B-5. Summary of EPA's Proposed Nutrient Criteria for Florida.

Nutrient Watershed Region	**In-stream Protection Value Criteria**	
	TN (mg/L)[a]	**TP (mg/L)[a]**
Panhandle [b]	0.043	0.043
Bone Valley [c]	1.798	0.739
Peninsula [d]	1.205	0.107
North Central [e]	1.479	0.359

[a] Concentration values are based on annual geometric mean not to be surpassed more than once in a three-year period. In addition, the long term average of annual geometric mean values shall not surpass the listed concentration values. (Duration = annual; Frequency = not to be surpassed more than once in a three-year period or as a long-term average).
[b] Panhandle region includes the following watersheds: Perdido Bay Watershed, Pensacola Bay Watershed, Choctawhatchee Bay Watershed, St. Andrew Bay Watershed, Apalachicola Bay Watershed, Apalachee Bay Watershed, and Econfina/Steinhatchee Coastal Drainage Area.
[c] Bone Valley region includes the following watersheds: Tampa Bay Watershed, Sarasota Bay Watershed, and Charlotte Harbor Watershed.
[d] Peninsula region includes the following watersheds: Waccasassa Coastal Drainage Area, Withlacoochee Coastal Drainage Area, Crystal/Pithlachascotee Coastal Drainage Area, Indian River Watershed, Caloosahatchee River Watershed, St. Lucie Watershed, Kissimmee River Watershed, St. John's River Watershed, Daytona/St. Augustine Coastal Drainage Area, Nassau Coastal Drainage Area, and St. Mary's River Watershed.
[e] North Central region includes the Suwannee River Watershed.

In the proposed rule, EPA acknowledges the important water resource role of clear streams and springs to the people of Florida and the anthropogenic effects that have caused degradation to these resources. The numeric nutrient criteria proposed by EPA for springs and clear streams (< 40 PCU) is written as follows in the proposed rule:

Nitrate (NO3)+Nitrite (NO2) shall not surpass a concentration of 0.35 mg/L as an annual geometric mean more than once in a three-year period, nor surpassed as a longterm average of annual geometric mean values.

EPA also dictates that TN and TP criteria for streams on a watershed basis also apply to clear streams.

In the proposed rule, EPA describes the diversity of canals and how they have changed ecosystems and hydrology in Florida. EPA proposes numeric nutrient criteria for canals classified as Class III waters under Florida Administrative Code (Rule 62-302.400). EPA notes that that proposed criteria would not apply for TP in canals within the Everglades Protection Area (EvPA) as a TP criterion of 0.010 mg/L currently applies to this area.

B.11 Georgia

Georgia has historically addressed nutrient issues on a site-specific basis. The state's WQS also include numeric limits for six publicly owned lakes. The state has developed a Plan for the Adoption of WQS for Nutrients (GEPD, 2008) that outlined the steps necessary to create nutrient criteria. The state's plan includes inventorying state waters, characterizing waterbodies, determining water quality parameters to be used as criteria, and selecting methods for determining compliance. The state will use both causal and response indicators, including nutrients and chlorophyll-a.

Georgia's antidegradation policy influences the permitting of a wastewater treatment plants and potential water quality offset. It is only through the building of facilities capable of levels of treatment beyond their permits that facilities can trade water quality credits. If antidegradation policy is written is such a way as to force all permit holders to achieve the maximum level of treatment possible, there will be no room for water quality trading.

A possible conflict between the goal of increased water quality trading and antidegradation policy arose in Gwinnett County where the F. Wayne Hill Water Resources Center had upgraded its facilities with state-of-the art ultrafiltration technology and was issued a permit to discharge. The plant was able to achieve much greater levels of treatment than was required by the permit that was issued by the State of Georgia. The permit was challenged on the basis that the permit violated the State's antidegradation policy because the policy requires permittees to utilize the "***highest and best [level of treatment] practicable under existing technology.***" Since the plant was capable of removing more pollution than the permit required, the permit discharge limits were tightened to match the level of treatment capable by the facility. The state's antidegradation policy has since been changed to eliminate this sentence.

The state has a Phosphorus Strategy that requires new or expanded facilities, greater than 1 mgd, to have an effluent TP limit of 1 mg/L. Facilities with flows less than 1 mgd will have effluent TP limits of 8.34 lb/day.

NPDES permits in Georgia that include effluent nutrient limitations include monthly and weekly average concentration and load limits that can be vary by month or season.

B.12 Hawaii

Most point source dischargers in Hawaii discharge through deep ocean outfalls, injection wells, or reuse. There are only two significant inland stream/lake dischargers so there is not much emphasis on stream/lake dischargers. Injection well discharges are regulated by underground injection control permits rather than NPDES permits.

For ocean outfalls, dischargers need to monitor for and meet receiving water nutrient limits of the State Water Standards in DOH's Chapter 54 (see http://water.epa.gov/scitech/swguidance/standards/upload/hi_wqs.pdf). Where there is a potential water quality concern, end-of-pipe effluent limits are established. Numeric criteria are included in the state WQS for TN, nitrate+nitrite, and TP. A summary of the inland criteria are listed in

The state WQS also include numeric limits for TN, ammonia, nitrate+nitrite, TP, and chlorophyll a for embayments, open coastal waters, and oceanic waters.

Table B-6. Hawaii Inland Water Quality Criteria.

Parameter	Geometric Mean not to Exceed	Not to exceed more than 10% of the Time	Not to exceed more than 2% of the time
Total Nitrogen (ug/L)	250.0* 180.0**	520.0* 380.0**	800.0* 600.0**
Nitrate+Nitrite (ug/L)	70.0* 30.0**	180.0* 90.0**	300.0* 170.0**
Total Phosphorus (ug/L)	50.0* 30.0**	100.0* 60.0**	150.0* 80.0**

*Wet season – November 1 through April 30.

**Dry season – May 1 through October 31.

Effluent limits are typically back-calculated based on evaluation of dilution factors, zone of mixing, and water quality limits.

Recently, the Hawaii Department of Health indicated that no changes are planned for the state WQS but that the trend is moving toward establishing effluent limits for the discharges. They are in the process of developing revised effluent limits and methods of determining compliance. The state will likely incorporate the use of geometric means, not-to-exceed ten percentile limits, and maximum single sample limits. When violations occur, they will likely require more intensive additional follow-up sampling.

B.13 Idaho

The state of Idaho has not developed or implemented numeric nutrient criteria. Additionally, Idaho does not have primacy for NPDES permits. The DEQ has not identified this as a priority and has been classified as just starting criteria process for years (Idaho DEQ, 2007). A significant lack of data has been cited as one of the challenges for developing numeric nutrient criteria. In 2012, the DEQ initiated a review of procedures related to nutrients. They have proposed a project to monitor for effects of nutrients on surface waters in Idaho to be started in 2013 and potentially be continued for additional years. This data may be useful for future numeric nutrient criteria development.

The Idaho Conservation League provided notice of intent to sue EPA regarding the inaction of the State of Idaho to develop an antidegradation implementation plan (Advocates for the West, 2009). They ascertain that because Idaho's water quality standard lacks an implementation plan, EPA should not approve any WQS until a plan is developed. If the State of Idaho does not develop a plan, then EPA should develop a plan for the state. The notice of intent includes the argument that the antidegradation policy requires state standards be sufficient to maintain existing beneficial uses. Therefore, without the policy and plan, it is impossible to know if appropriate WQS are being set.

The claim also argues that three tiers of waters need to be defined as part of the antidegradation policy and Idaho has also failed to identify any methods to implement a policy that relates the tiers to protecting water quality. The suit claims that Idaho and EPA have failed to follow the CWA requirements regarding antidegradation implementation plans and the setting of WQS.

Most of the recently issued NPDES permits in Idaho have included nutrient limits based on state-developed TMDLs for specific waterbodies. In two parts of the state, the TMDLs were developed for different states (Washington and Oregon) but the load or WLAs were included for the Idaho dischargers and EPA used that as the basis for the NPDES permit limits. Since Idaho does not have primacy and EPA Region V writes the NPDES discharge permits, the structure of the permits has varied by region and by permit writer. The preliminary draft NPDES permit for Coeur d'Alene includes a seasonal average phosphorus load limit that was calculated based on future plant flows. The seasonal average allows some flexibility in operation and based on the modeling results completed following the TMDL, is still protective of water quality. The draft Pocatello NPDES permit includes monthly and weekly average phosphorus load NDPES permit. The City of Boise NPDES permits include phosphorus limitations to meet the downstream Snake River-Hells Canyon DO TMDL. The Boise permits include May through September monthly and weekly concentration and load phosphorus limits.

B-14 Illinois

The Illinois WQS include criteria for phosphorus. "Phosphorus shall not exceed 0.05 mg/L in any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more, or in any stream at the point where it enters any such reservoir or lake." (35 IAC 302.205). Lake Michigan-specific standards for nutrients include a not to exceed standard of 0.007 mg/L TP and 10.0 mg/L nitrate-nitrogen. The open waters of Lake Michigan must not exceed 0.02 mg/L total ammonia and the remaining waters of the Lake Michigan basin must not exceed 15 mg/L total ammonia. Illinois has not adopted similar effluent limits for discharges into other bodies of water. The Illinois EPA initiated a statewide Nutrient Reduction Strategy in 2013.

B-15 Indiana

Indiana currently requires phosphorus removal from facilities that have a daily discharge of 10 pounds or more of phosphorus and discharge within the Lake Michigan or Lake Erie watershed or directly enter a lake or reservoir or a tributary within 40 miles upstream of a lake or reservoir. Nutrient impairment in Indiana lakes is determined based on TP and chlorophyll-a concentrations.

The proposed rulemaking would adopt eutrophication criteria for natural lakes and reservoirs including TP as a causal variable and chlorophyll-a as a response measurement.

The draft nutrient criteria in Indiana include the following:

- Chlorophyll-a – 8 μg/L.
- TP – 25 μg/L for natural lakes; 35 μg/L reservoirs.
- Annual mean not to be surpassed once every three years.

Based on communication with Indiana Department of Environmental Management permitting staff, as of mid-2013 no NPDES discharge permits have been updated to include limitations based on the draft lakes criteria. The state is in the process of developing an implementation plan that will define how the criteria will be incorporated into NPDES permits. Following the completion of the implementation plan, the criteria will go to rule-making in the state to be adopted as part of the WQS. The state is working on collecting data to begin development of river/stream nutrient criteria but there is not a firm schedule for this process.

B.16 Iowa

In May 2013, Iowa updated the "Iowa Nutrient Reduction Strategy", which was released in November 2012. This strategy will require 102 major municipal wastewater treatment plant dischargers to write a report describing the "reasonableness" of implementing nutrient removal at their facilities. This "reasonableness" is based on the cost of implementing each of three tiers of nutrient removal and comparing that with the communities' economics. Unless deemed economically unreasonable, all listed dischargers will be required to do some level of nutrient removal. It is important to note that the Nutrient Reduction Strategy is not a water quality standard or administrative rule but it can impact how the state approaches establishing numeric nutrient criteria.

Some other NPDES discharger related issues in the Nutrient Reduction Strategy include:

- If a permitted discharger installs nutrient reduction processes and technology-based TN and TP limits are included in the NPDES permit, then it is the position of the Iowa Department of Natural Resources (DNR) that the TN and TP discharge limits will not be made more restrictive for a period of at least 10 years after the completion of the nutrient reduction process construction.
- Permit limits for TN and TP will be expressed as an annual average.
- Dischargers will have a one year fine-tuning period for process optimization and performance evaluation.
- When determining the appropriate point source WLA to be used in the TMDL calculation, the Iowa DNR will consider this point source nutrient strategy as the basis for setting the WLA for point sources. The Iowa DNR will not impose effluent limitations in NPDES permits that require load reductions beyond the reductions achieved by implementation of this strategy unless it is determined necessary to allow the stream or lake to meet Iowa WQS.

The effluent TN and TP limits will be annual average mass limits and will be calculated as the sum of all measurements for a given pollutant collected during a 12-month period (Iowa DALF, et al., 2013). The nutrient strategy will be implemented in a phased approach. The first phase is a nutrient study at the wastewater treatment facility to identify and quantify the nutrient loads coming into the plant and leaving the plant. After this two-year study, a report will be submitted to Iowa DNR indicating the results, the plan for process upgrades to achieve future nutrient reduction, how the nutrient reduction strategy will be implemented, and a construction schedule for installation of the nutrient reduction improvements. Following construction, a one-year optimization period will be provided to determine how the process works full-scale. Then technology-based effluent limits will be established based on the full-scale performance. The estimated rule of thumb effluent limits are 10 mg/L TN and 1 mg/L TP, but the final limits could be more or less stringent depending on performance, cost, and other details specific to the discharger. The nutrient reduction strategy applies to municipal dischargers with flows greater than one million gallons per day as well as all major industries and 19 minor industries that may discharge nutrients. There is no expected construction schedule; it is depending on what the facility determines in their study period.

B.17 Kansas

Currently, there are no numeric nutrient criteria for surface waters developed in Kansas. Mike Tate, from the Kansas Department of Health and Environment, says that the completion of statewide numeric nutrition criteria is likely about three to five years away. However, many major NPDES permit dischargers currently require nitrogen and phosphorus monitoring.

In 2004, Kansas released a surface water nutrient reduction plan with a goal of reducing nutrients that leave the state by 30 percent. The approach concept was to create an inventory of nutrients in the state and for waters leaving the state and establish a fixed reduction target (Kansas DHE, 2004). Kansas' target is to have major NPDES permit holders upgrade to include biological nutrient removal to treat to an annual average of 1.5 mg/L TP and 8.0 mg/L TN, and to incorporate this into permits over the next 15 years. Unlike in Nebraska, implementing these limits on major dischargers would reduce nutrient export from the state by as much as 14 percent. Many municipalities are in the process planning for and implementing biological nutrient removal in their treatment process.

B.18 Kentucky

The Kentucky Division of Water, in the Department for Environmental Protection, is developing a Nutrient Reduction Strategy that is focused on reducing nutrients entering Kentucky waters. A draft of the Nutrient Reduction Strategy has been developed and includes source identification, ongoing programs, monitoring, and targeting to prioritize watersheds (Kentucky DEP, 2014). Through this strategy, the state has a goal of developing Source Specific Strategies for Nutrient Management. The strategy balances nutrient reductions from point sources and nonpoint sources but does not yet include a plan for developing numeric nutrient criteria.

B.19 Louisiana

Louisiana does not currently have numeric nutrient criteria in the state's WQS. In 2013, Louisiana DEQ along with several other state agencies, including Louisiana Department of Agriculture and Forestry, Louisiana DNR, and the Coastal Protection and Restoration Authority, began work on a comprehensive nutrient management strategy. The strategy includes stakeholder engagement, decision support tools, regulations and policies, management practices, trends, watershed characterization and source identification, incentives and funding, targets and goals, monitoring, and reporting. Part of the work completed as part of the nutrient management strategy is to set a baseline for the state and determine the 'appropriate levels' of nutrients for Louisiana waters (Louisiana DEQ, 2013). The nutrient strategy includes a targeted date of 2018 to complete the strategic actions, which include activities like watershed characterization and prioritization, and trending of permitted discharger inventories (Louisiana DEQ, 2014).

B.20 Maine

The Maine DEP initiated nutrient criteria rulemaking in response to EPA's requirement that states develop and adopt numeric criteria for nitrogen and phosphorus. Maine DEP proposed the use of a decision framework that will allow the state to determine if there is a water quality impairment, then determine what the cause of the impairment is (nitrogen, P, etc.) (Maine DEP, 2009). The decision framework is based on existing numeric criteria, uses, and narrative criteria, listed below:

- Numeric criteria:
  - pH.
  - DO concentrations and saturation.
  - Aquatic life criteria.
- Uses and narrative criteria:
  - Recreation in and on the water.
  - Aquatic life.
  - Trophic state.
  - Habitat.

The nutrient criteria for surface waters were revised in 2011 and submitted to EPA Region 1 for review and comment. EPA stated that the approach the Maine DEP is taking is consistent with the CWA with the addition of a few technical edits and recommendations (EPA, 2011).

The decision framework in the 2011 draft nutrient criteria combines mean TP concentrations with several response indicators to determine if surface water is impaired, and if site-specific criteria are appropriate. The decision framework is presented in Table B-7.

Table B-7. Decision Framework.
(Maine DEP Nutrient Criteria for Surface Waters, 2012).

	Mean total phosphorus concentration is less than or equal to the applicable criterion in Table 2 or an established site-specific criterion.	Mean total phosphorus is greater than the applicable criterion in Table 2 or an established site-specific criterion.
All measured response indicators meet criteria.	Box A. **Not Impaired.** Nutrient criteria attained.	Box B. **Not Impaired.** Department conducts a study to determine attainment status and requirement of site-specific criteria.
One or more of the response indicators do not meet criteria.	Box C. **Impaired.** Indeterminate cause requires weight-of-evidence analysis to determine cause of impairment.	Box D. **Impaired.** Nutrient criteria not attained.

The TP criteria for different water classes are presented in Table B-8 and the criteria response indicators are shown in Table B-9.

Table B-8. Total Phosphorus Criteria either Measured as an Average of Water Samples or Computed by the Diatom Total Phosphorus Index (DTPI).
(Maine DEP Nutrient Criteria for Surface Waters, 2012).

Statutory Class	Total Phosphorus Criterion (ppb)
AA and A	≤18.0
B	≤30.0
C	≤33.0
GPA	≤15.0

Table B-9. Criteria for Response Indicators.
(Maine DEP Nutrient Criteria for Surface Waters, 2012).

<table>
<tr><th rowspan="2"></th><th colspan="7">Statutory Class</th></tr>
<tr><th>AA/A</th><th>B</th><th>C</th><th>A Impounded</th><th>B Impounded</th><th>C Impounded</th><th>GPA</th></tr>
<tr><td></td><td>≤18.0 µg/L (ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td><td>≤30.0 µg/L (ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td><td>≤33.0 (ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td><td>≤18.0 µg/L(ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td><td>≤30.0 µg/L (ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td><td>≤33.0 µg/L (ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td><td>≤15.0 µg/L(ppb) TP[a] and all of the response indicator[b] values in this column OR all of the response indicator[b] values in this column</td></tr>
<tr><td>Percent algal cover[c]</td><td>≤20.0</td><td>≤25.0</td><td>≤35.0</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Water Column Chl a (µg/L, ppb)</td><td>≤3.5
(≤5.0[d])</td><td>≤8.0</td><td>≤8.0</td><td>≤5.0</td><td>Spatial mean ≤8.0 and no value >10.0</td><td>Spatial mean ≤8.0 and no value >10.0</td><td>≤8.0</td></tr>
<tr><td>Secchi Disk Depth (m)</td><td colspan="7">≥2.0</td></tr>
<tr><td>Patches of bacteria and fungi</td><td colspan="7">None observed</td></tr>
<tr><td>pH</td><td colspan="5">6.0-8.5</td><td></td><td></td></tr>
<tr><td>Dissolved Oxygen (mg/L, ppm)[a]</td><td colspan="5">As per 38 M.R.S.A. §465</td><td>--</td><td>--</td></tr>
<tr><td>Aquatic life[a]</td><td colspan="5">As per 38 M.R.S.A. §464 and §465 and where applicable Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams, 06-096 CMR 579 (Effective May 27, 2003)</td><td colspan="2">As per 38 M.R.S.A. §465-A</td></tr>
</table>

[a] The total phosphorus (TP) values for the statutory class applies unless a site specific value has been adopted.

[b] Response indicators include percent algal cover, water column chlorophyll a, Secchi disk depth, patches of bacteria and fungi, pH, dissolved oxygen, and aquatic life criteria. Concentrations of cyanotoxics should be within appropriate health guidelines for recreational exposure. When implementing the criteria, the Department applies the appropriate combination of response indicators depending on the waterbody type (e.g., wadeable vs. deep, rocky vs. unconsolidated substrate, flowing vs. not flowing). Some response indicators are not applicable to all waterbody types.

[c] Percent algal cover is applicable to waters less than 1.25 meters in depth.

[d] Applicable to low gradient Class AA or A waters with water velocity less than 5.0 centimeters per second.

The draft nutrient criteria rule states that at least three years of data are required to establish new site-specific criterion, including at least one year with critical ambient conditions (Maine DEP, 2012). Additionally, site-specific criteria cannot be greater than the “mean of the annual TP means.” Where site-specific analysis or criteria have not been developed, DEP will use the phosphorus criteria Table B-8 to establish limits. The draft rule also states “The Department may establish discharge limits for organic material, such as total suspended solids or biochemical oxygen demand, as alternatives to phosphorus limits if organic enrichment accompanies phosphorus enrichment and controlling organic enrichment is an appropriate means of restoring or maintaining WQS" (Maine DEP, 2012).

B.21 Maryland

Maryland is one of the states that have load allocations and a watershed implementation plan for the Chesapeake Bay TMDL, which is described in Section B.52. In addition to the Chesapeake Bay nutrient program, the state implements nutrient limits into NPDES permits through TMDLs with effect endpoints like DO or chlorophyll-a.

B.22 Massachusetts

The Commonwealth of Massachusetts does not currently have statewide numeric nutrient criteria. Massachusetts developed a Plan for the Development of Nutrient Criteria for Lakes, Rivers, Streams and Marine Waters, which was updated in 2004. The plan includes a review of several nutrient criteria development methods which a preference for classifying waterbodies by various characteristics and looking at many variables (chlorophyll-a, filamentous algae, DO, TP, TN).

The state's narrative criteria mention point sources of nutrients specifically:

Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses.

http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/Massachusetts-Plan-for-the-Development-of-Nutrient-Criteria-for-Lakes-Rivers-Streams-and-Marine-Waters.pdf

B.23 Michigan

The State of Michigan began controlling phosphorus to Lake Michigan through narrative WQS in 1968 (Michigan DEQ, 2011). The Great Lakes Water Quality Agreement (GLWQA), an agreement between the United States and Canada, was established in 1972 and renewed in 1978 to reduce and control nutrients in the Great Lakes Basin System. In Michigan, this meant WWTPs discharging more than 1 mgd were designed to achieve effluent TP concentrations less than 1 mg/L when discharging to Lake Superior, Michigan, and Huron and 0.5 mg/L in Lake Erie. Michigan revised the states WQS in 1973 and included numeric phosphorus goals for point source dischargers equal to a monthly average effluent concentration of 1 mg/L (these became limits in 1986). In 1977, Michigan banned the use of phosphates in laundry detergents.

In 2004, Michigan DEQ began working with Michigan State University to establish site-specific numeric nutrient criteria for lakes, rivers, streams, and impoundments. The approach integrated both nutrient modeling to predict lake-specific nutrient conditions and biological thresholds. Michigan DEQ wanted to have an implementation process in place prior to the draft rules going to public comment. While the implementation was in development, the governor passed legislation that prohibits DEQ from revising current rules or developing new ones.

B.24 Minnesota

The Minnesota Pollution Control Agency (MPCA) plans to establish new or revised WQS as part of its Proposed WQS Rule Revisions: 2008-2012 Triennial Water Quality Rule Review. The new WQS include nutrient criteria for rivers and lakes. MPCA used ecoregion-based criteria including regionalization of Minnesota's rivers and lakes. According to MPCA, since 2008 the criteria have been used for 303(d) assessments and setting permit limits. The lake regions reflect regional patters caused by landform, soil type, potential natural vegetation, and land use (MPCA, 2015b). The river regions reflect regional patterns and are based on differences in geomorphology (MPCA, 2015b).

Lake eutrophication criteria are shown in Table B-10. River eutrophication criteria are shown in Table B-11. Eutrophication criteria for Mississippi River pools and Lake Pepin are shown in Table B-12. These criteria will be the basis for an impaired water list, following the water quality data assessment. Waters that are listed as impaired will require TMDLs and the WLAs will inform NPDES discharge permits.

Table B-10. Lake Eutrophication Criteria by Lake Nutrient Region for Minnesota.

	Nutrient	**Stressor**	
Region	TP (µg/L)	Chl-a (µg/L)	Secchi Depth (m)
North Lakes Forests – deep	20	6	2.5
North Lakes Forests – shallow	30	9	2
North Central Hard Forests – deep	40	14	1.4
North Central Hard Forests – shallow	60	30	1.0
West Corn Belt Plains – deep	65	22	0.9
West Corn Belt Plains – shallow	90	30	0.7

Table B-11. River Eutrophication Criteria by River Nutrient Region for Minnesota.

	Nutrient	**Stressor**		
Region	TP (µg/L)	Chl-a (µg/L)	DO flux (mg/L)	BOD_5 (mg/L)
North	≤50	<7	≤3.0	≤1.5
Central	≤100	<18	≤3.5	≤2.0
South	≤150	<35	≤4.5	<3.0

Table B-12. Mississippi River Pools and Lake Pepin Eutrophication Criteria.

Region	**TP (µg/L)**	**Chlorophyll-a (ug/L)**
Pool 1	100	35
Pool2	125	35
Pool 3	100	35
Lake Pepin	100	28
Pools 5-8	100	35

B.25 Mississippi

The State of Mississippi does not currently have statewide numeric nutrient criteria. In 2010, the state completed "Mississippi's Plan for Nutrient Criteria Development", which is a mutually agreed upon document with EPA Region IV. The purpose of the plan is to identify the approach that Mississippi will take to develop nutrient criteria. The focus of the Mississippi DEQ strategy is to develop criteria that are based on a linkage between nutrient concentrations and the impairment of designated uses (Mississippi DEQ, 2010). A variety of cause and response indicators are being considered at this time.

B.26 Missouri

Missouri currently has nutrient limits for wastewater discharges to the Table Rock Lake and Lake Taneycomo watersheds. In addition, the James River TMDL (a major tributary to Table Rock Lake) set in-stream TP and TN targets of 0.075 mg/L and 1.5 mg/L, respectively. There are 23 wastewater treatment facilities that discharge in the James River watershed. The WLA for each facility is 0.5 mg/L TP year round, with the exception of facilities under 22,500 gpd that existed prior to the TMDL and have not been expanded since then. TP permit limitations for these facilities are 0.5 mg/L expressed as a monthly average. Discharge limitations for other facilities within the Table Rock Lake and Lake Taneycomo watersheds are equivalent.

In 2011, Missouri adopted lake and reservoir nutrient water quality criteria (nitrogen, phosphorus, and chlorophyll *a*); however, these criteria for the majority of state lakes and reservoirs were disapproved by EPA. The approved criteria for reference lakes and reservoirs are not being implemented by Missouri DNR until the disapproval is addressed. The Missouri DNR and EPA are reassessing the technical approaches to develop revised lake and reservoir nutrient criteria. Missouri DNR hopes to adopt approvable lake and reservoir criteria by 2015 and possibly adopt stream nutrient criteria within this timeframe as well.

In 2010, EPA and Missouri DNR developed nine TMDLs on effluent dominated streams that set loading capacities at very stringent, eco-regional criteria. Municipal and industrial WLAs ranged from 7 to 120 ug/L TP and 290 to 880 ug/L TN. In 2013, EPA objected to the City of Fulton's draft NPDES permit that did not include the assigned WLA as permit limits. EPA, Missouri DNR, and the City entered into extensive discussions to resolve this interim permit objection. Ultimately, the final draft permit includes a phased, 22-year compliance schedule to achieve the final effluent limits which are based on the limit of technology (0.1 mg/L TP and 4 mg/L TN). A WQS variance is in the approval process to address the difference between the final limits and the assigned WLA. Two sets of interim limits are provided within the permit, with the first phase including elimination a wet weather bypass and secondary treatment upgrades. The second phase includes implementing biological nutrient removal. Additionally, the stream assessments will be completed throughout the 22-year compliance schedule to either demonstrate use attainment or require modification to the TMDL. If the uses of the receiving stream are attained prior to the end of the 22-year compliance schedule, then implementation of further control steps will be terminated.

B.27 Montana

The State of Montana began developing numeric nutrient criteria in the early 2000s. Montana's approach has included review of reference stream criteria, scientific studies to develop a technical basis for wadeable streams criteria, site specific investigations of some larger key rivers, and a public survey of perceptions of stream health and bottom algae where respondents viewed photographs to determine whether the conditions were desirable or undesirable. Based on these studies, the Montana DEQ initiated a rule-making phase for state adoption of numeric nutrient standards in 2010.

Montana developed water quality variance legislation anticipating adoption of numeric nutrient standards would result in conditions that would be too expensive or infeasible from the standpoint of wastewater treatment technology. Montana Senate Bill 95 provides for temporary nutrient criteria to establish permit limits for point source discharges to surface water and became law in 2009 (MCA 75-5-313). On a case-by-case basis, Montana DEQ may approve the use of temporary nutrient criteria if the attainment of the base numeric nutrient standards is precluded due to economic impacts, or the limits of treatment technology.

Montana has established wadeable stream standards of 0.3 mg/L TN and 0.03 mg/L TP for most of the state; there is some variation (slightly higher) for the eastern parts of the state. Montana DEQ intends to go to rulemaking in October 2013. Senate Bill 367 provides a variance from those criteria at 10 mg/L TN and 1 mg/L TP which is available until May of 2016.

B.28 Nebraska

Currently, Nebraska has numeric TP and TN standards for lakes and reservoirs, but not for streams or rivers. While ammonia is a standard constituent with WLAs on most municipal WWTP NPDES permits, TN and nitrate are not typically included as effluent limitations in NPDES permits.

Nebraska DEQ is working with the University of Nebraska – Lincoln to gather data to develop stream and river numeric nutrient criteria. While preliminary TN and TP numeric criteria have been developed, there are no plans to introduce these criteria in the next triennial review.

B.29 Nevada

Nevada has statewide numeric phosphorus criteria and site specific WQS for many waterbodies. Biological monitoring is used to confirm impairment listings.

B.30 New Hampshire

New Hampshire does not have statewide numeric nutrient criteria. The New Hampshire WQS state that, in "Class A waters shall contain no phosphorus or nitrogen unless naturally occurring," "There shall be no new or increased discharge of phosphorus into lakes or ponds", and "There shall be no new or increased discharge(s) containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds."

In a 2010 document, the state is evaluating the development of numeric nutrient criteria for rivers and streams using the following approach (New Hampshire DES, 2010).

- Review existing regional criterion.
- Extract and analyze existing data.
- Recommend interim numeric criteria.
- Undertake stress/response study.
- Utilize multiple lines of evidence to propose final numeric criteria.

- ♦ Develop range of TP criterion based on data distribution (data – 1990-2009, 1,100 assessment units (AUs), non random data, median TP concentration/AU; identify percentiles [5, 10, 75, 90, 95], establish categories [reference, no DO impairment, all AUs, DO impaired AUs].

Ultimately the proposed numeric nutrient criteria will be based on multiple lines of evidence including the distribution of nutrient data and the stress/response relationships. The schedule includes completing final numeric nutrient criteria in 2013. The New Hampshire Department of Environmental Services (DES) has developed numeric water quality criteria for the Great Bay Estuary. The annual median total nitrogen concentration thresholds are 0.25 to 0.45 mg/L.

B.31 New Jersey

The New Jersey WQS include both numeric phosphorus criteria and narrative nutrient standards that prohibit excess algal growth and nuisance aquatic vegetation. The state established numeric phosphorus criteria in 1981, however the basis for the numeric criteria is unclear. Based on a conversation with one of the state water quality experts, New Jersey DEP has determined that the existing criteria are not always effective at protecting water quality. In some areas the 0.1 mg/L TP in stream target is achieved but based on biological indicators, the stream is still impaired.

The existing WQS state that phosphorus shall not exceed 0.05 mg/L TP in freshwater lakes and 0.1 mg/L in freshwater streams (New Jersey DEP, 2009). All New Jersey Pollutant Discharge Elimination System (NJPDES)-regulated facilities that discharge to freshwater lakes, ponds, reservoirs, or tributaries receive a 1 mg/L effluent TP limit, as a monthly average.

The state has completed a plan for developing nutrient criteria for all waters of the state (New Jersey DEP, 2009). The Nutrient Criteria Enhancement Plan outlines several steps for the development and enhancement of nutrient criteria, including increased monitoring, determining cause and response relationships, defining thresholds of use impairment, and ultimately the development of new criteria (New Jersey DEP, 2009).

While statewide nutrient criteria are in development, the state is including water quality based effluent limitations for renewed NJPDES permits to ensure TP WQS are not exceeded. In areas where the numeric nutrient criteria are exceeded, dischargers have the opportunity to demonstrate compliance with the narrative nutrient criteria based on the New Jersey DEP's "Technical Manual for Phosphorus Evaluations for NJPDES Discharge to Surface Water Permits". Dischargers must show that the effluent phosphorus levels do not cause symptoms of eutrophication thus rendering them unsuitable for their use (New Jersey DEP, 2009). The Allumuchy Sewerage Treatment Plant received a NJPDES permit that included monthly average effluent TP concentrations equal to the state water quality standard for streams. The permit also included language allowing the discharger to complete a site-specific evaluation to prove that phosphorus was not the limiting nutrient. The text below was cut from the first permit to illustrate the structure of the NJPDES permits. A site-specific evaluation completed by the Township of Allamuchy was unable to show that the narrative criteria were met so a TMDL was completed and a second permit was issued that included the new effluent TP limits.

<u>Phosphorus</u>: The concentration limitations are based on the requirements of N.J.A.C. 7:14A-13.6(a), to impose WQBEL when the discharge of a pollutant exceeds the SWQS. As

there is no instream dilution under critical conditions (MA7CD10 = 0 cfs) the phosphorus critical value of 0.1 mg/L must be achieved in the effluent prior to discharge, therefore a monthly average phosphorus limitation of 0.1 mg/L has been included in the permit. This permit contains WQBELs for phosphorus with a compliance schedule that requires attainment of the limitation no later than EDP + 59 months.

The compliance schedule also provides the permittee the option of undertaking studies/demonstrations consistent with the provisions of the water quality criteria for phosphorus (N.J.A.C. 7:9B-1.14(c)), that could lead to the Department proposing to modify or remove the effluent limitations.

In accordance with 7:14A-13.6(a), a WQBEL shall be imposed when the Department has determined that the discharge causes an excursion above the criteria specified in the Surface WQS at N.J.A.C. 7:9B. In accordance with N.J.A.C. 7:9B-1.14(c), the criteria for TP is 0.1 mg/L except where site-specific or watershed criteria are developed or it can be demonstrated that TP is not a limiting nutrient and will not otherwise render the waters unsuitable for the designated uses.

At this time, the Department does not have evidence to conclude that phosphorus is not the limiting nutrient in the receiving stream, nor that the discharge of phosphorus from the permittee will not render the waters unsuitable for the designated uses. Furthermore, site-specific or watershed criterion has not been developed for the Pequest River segment in to which the permittee discharges. Therefore, the numerical criterion of 0.1 mg/L (TP) is applicable for this receiving water.

Monthly average loading limitations for the permitted flow of 0.6 MGD has been included in accordance with N.J.A.C. 7:14A-13.14(a)1. Weekly average concentration and loading monitoring and reporting conditions for the above referenced flows have been included based on N.J.A.C. 7:14A-6.2(a)14.

In accordance with N.J.A.C. 7:14A-6.4(a), a schedule to achieve compliance with the new WQBELs for phosphorus has been included in this permit.

During the compliance schedule period, the permittee is required to submit progress reports in accordance with N.J.A.C. 7:14A-6.4(a)2ii. Refer to the Compliance Schedule section of this fact sheet for further details. Upon submission of any of the studies and reports outlined in Part IV, the Department may consider proposing a modification to this permit to remove or modify the final WQBELs proposed for phosphorus.

A site-specific evaluation completed by the Township of Allamuchy was unable to show that the narrative criteria were met so a TMDL was completed and a second permit was issued that included the new effluent TP limits.

Upon reviewing the facility's phosphorus data for the summer (May 1 - October 31) and winter months (November 1 - April 30), the Department determined that beginning in April 2009, the seasonal phosphorus data showed that the treated effluent is able to consistently comply with the new TMDL monthly average loading limitations of 1.32 kg/day (summer) and 1.94 kg/day (winter). Therefore, no schedule of compliance has been included in the permit, with the aforementioned TMDL limitations to begin on the effective date of the permit.

B-32 New Mexico

The State of New Mexico currently has narrative nutrient criteria. The New Mexico Environment Department (NMED) developed a Nutrient Criteria Development Plan in 2007 (NMED, 2008). The purpose of the plan was to identify how the state would develop nutrient threshold values for different waterbody types. Based on information in the plan, statistical analyses will be used to classify the waterbodies and determine threshold values for select variables. The plan is for the state to adopt numeric nitrogen and phosphorus criteria into the state WQS. The proposal and adoption of numeric nutrient criteria do not have scheduled completion dates at this time (NMED, 2013).

B-33 New York

The state of New York has existing narrative standards for nitrogen and phosphorus, stating that these nutrients are not in amounts that "will results in the growths of algae, weeds, and slimes that will impair the waters for their best usages." New York also has an existing ambient water quality guidance value of 0.020 µg/L TP that was established as a translation from the narrative standard to protect ponds, lakes, and reservoirs (Classes A, AA, A-S, AA-S, and B).

New York has established nitrogen limits for POTWs discharging into the Long Island Sound, Jamaica Bay, and Chesapeake Bay watersheds. Water body-specific phosphorus criteria have been established for Lake Erie, Lake Ontario, Lake Champlain, and the New York City Watershed reservoirs. Table B-13 summarizes the existing water body-specific criteria.

Table B-13. New York Waterbody Specific Phosphorus Criteria.
(New York State Nutrient Standards Plan, 2011).

Lake	Criteria	Comments
Lakes Erie and Ontario	Lake Erie, Western Basin: 15 ug/L Lake Erie, Central and Eastern Basins: 10 ug/L Lake Ontario: 10 ug/L	Great Lakes Water Quality Agreement
Lake Champlain (NY side)	Main Lake: 10 µg/L South Lake: 25-54 µg/L Remainder of lake: 14 µg/L	1993 New York-Quebec-Vermont Water Quality Agreement; Used in the TMDL
New York City Watershed reservoirs	Terminal reservoirs: 15 µg/L	This value with the statewide guidance value of 20 µg/L was used in the reservoir TP TMDL

The initial focus on freshwater nutrient criteria in New York is on phosphorus, as it is believed to be the limiting nutrient for inland waters (NYSDEC, 2011). The state has completed data collection and analysis for rivers, streams, lake, and reservoirs and is currently developing the proposal of phosphorus criteria. Draft values have been shared with EPA and are scheduled to be released to the public by the end of 2012 (NYSDEC, 2011) for adoption in 2013. The Nutrient Standards Plan stated that criteria development would include causal stressors (phosphorus) and response variables, such as chlorophyll a, water clarity, and biological impact.

B.34 North Carolina

The state of North Carolina has not developed or implemented numeric nutrient criteria. While the state has a long history of water quality management including the protection of nutrient sensitive waters, the preferred management approach has been to try to avoid setting statewide numeric standards. The state has taken a strategy of continuing existing nutrient management programs and a proactive approach to recognizing enrichment prior to impairment. This includes recognizing the causes of excessive nutrients and the relationships to effects, such as chlorophyll-a concentrations. Nutrient limits have been independently developed for river basins including the Cape Fear River, Catawaba River, Chowan River, Neuse River, Roanoke River, Tar-Pamlico River, White Oak River, and Yadkin River.

This approach led to the development of a proposal to prevent nutrient impairment of waterbodies, referred to as the threshold rules. "In Fall 2009, the North Carolina Division of Water Quality (NC DWQ) presented new proposed "threshold rules" to the Water Quality Committee (WQCo) of the Environmental Management Committee (EMC) that would establish a more proactive nutrient management program aimed at preventing nutrient impairment within the State's watersheds. The proposed threshold rules were distinctly unique to nutrient management strategies being developed in other parts of the country" (Bailey, et.al, 2011). However, in November 2010, the proposed threshold rules failed to gain acceptance and be adopted.

The latest proposals by the NC DWQ, while similar in name, will take new forms at attempts for nutrient regulations. These include: a numeric nutrient criteria implementation plan, a proposal to prevent nutrient impairment of waterbodies, and a long-planned nutrient control strategy. These were the significant nutrient control proposals summarized as Looking Forward from the North Carolina on Nutrient Over-Enrichment held May 29 and 30, 2012, to the EMC on July 12, 2012 (EMC, 2012 and NCLM, 2012).

B.35 North Dakota

The state of North Dakota has not developed numeric nutrient criteria and currently does not have phosphorus effluent limits in discharge permits. Some NPDES permits have site-specific ammonia limits. The state has initiated a planning process for the development of nutrient criteria, starting with lakes and reservoirs. Two pilot scale review processes have been completed looking at the process to develop criteria within the state and comparing nutrient criteria in lakes and reservoirs across the region.

While the nutrient criteria plan has not been established, the state intends to use the cause and effect relationship to establish criteria, not just a statistical distribution of data (telephone interview, 2012). The draft plan has a nine year schedule for nutrient criteria development and implementation. The list of water body priorities is shown below:

- ♦ Large reservoirs and deep natural lakes.
- ♦ Shallow natural lakes and small reservoirs.
- ♦ Perennial wadeable rivers and streams.
- ♦ Perennial non-wadeable (large) rivers and streams.

- Intermittent (ephemeral) streams.
- Wetlands.

B.36 Ohio

The Ohio EPA plans to develop and implement a nutrient reduction strategy that includes feedback from citizens, industry, stakeholders, and affected communities (Ohio EPA, 2011). In early 2013, the Ohio EPA completed the "Early Stakeholder Outreach" process as required for rulemaking in Ohio. The summary of the outreach stated that for streams and rivers, Ohio EPA has developed a multi-metric scoring system which combines information from separate evaluations of primary productivity, biological health, and in-stream nutrient concentrations. The output from the scoring system provides a TIC, which integrates stressor variables that potentially cause stream degradation (as shown by response variables). The stressor include nitrogen and phosphorus concentration and the responses are 'biologically important stream attributes" (Ohio EPA, 2013). A draft version of the rules is scheduled to be out for public comment later in 2013.

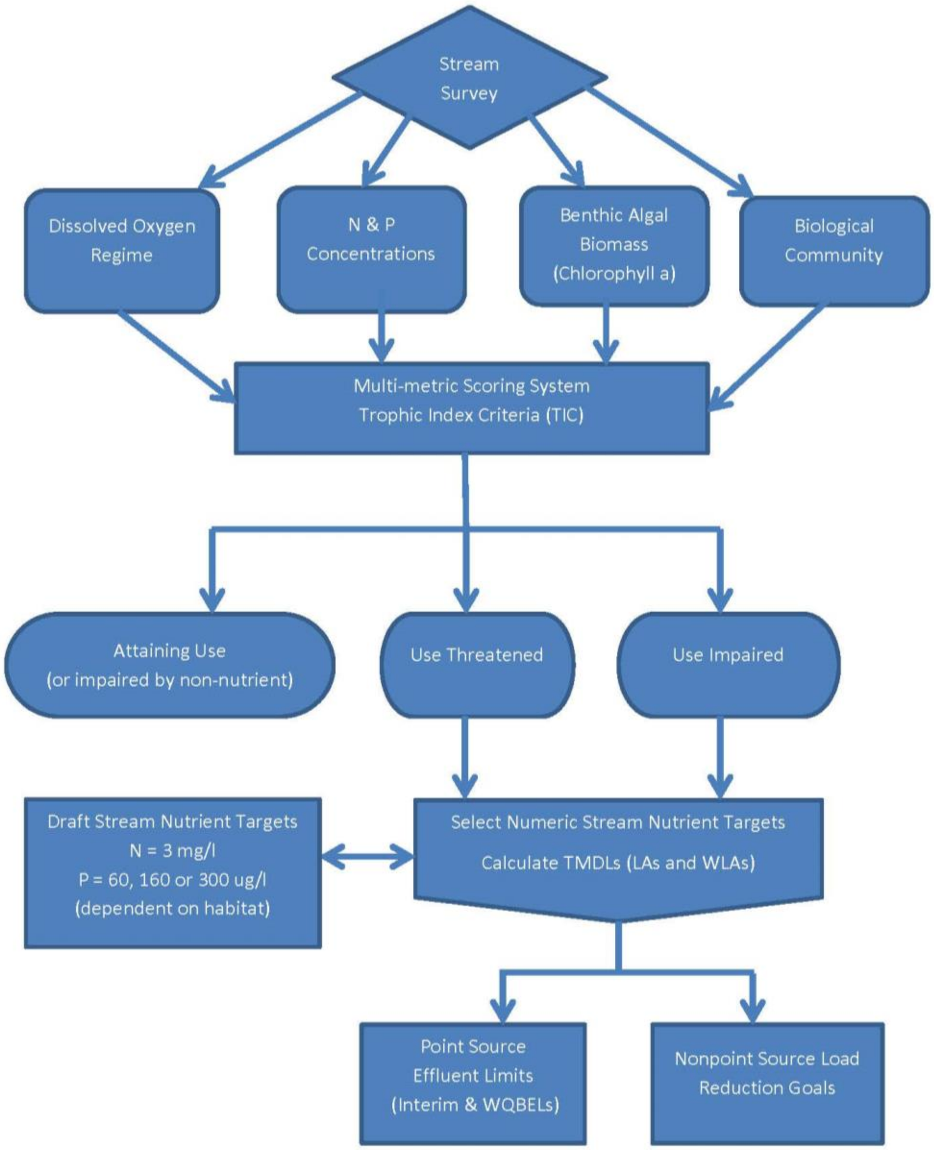

Figure B-4. Conceptual Design of Trophic Index Criterion in Ohio.

The Ohio EPA established phosphorus and ammonia criteria that were finalized in 2011. The water use designations and statewide criteria include numeric criteria for phosphorus and ammonia (Ohio EPA, 2011). Two types of criteria apply, "outside mixing zone" where receiving water and effluent are 'reasonably well mixed' and "inside mixing zone" where end-of-pipe maximum effluent limits apply. The nutrient criteria vary by water body designation; the coldwater habitat waterbodies require more stringent limitations compared to the warmwater habitat waterbodies.

The total ammonia nitrogen criteria vary based on the receiving water pH and temperature. The range of outside mixing zone maximum and 30-day average total ammonia-nitrogen criteria are summarized in Table B-14.

Table B-14. Total Ammonia-Nitrogen Criteria.
(State of Ohio Water Quality Standards, 2011).

Waterbody Designation	Outside Mixing Zone Maximum	Outside Mixing Zone 30-Day Average
Warmwater habitat	1.1-13.0 mg/L	Dec-Feb: 0.3-13.0 mg/L Mar-Nov: 0.1-2.3 mg/L
Modified warmwater habitat		Dec-Feb: 0.3-13.0 mg/L Mar-Nov: 0.2-3.4 mg/L
Limited resource water		
Exceptional warmwater habitat	0.7-13.0 mg/L	Dec-Feb: 0.3-13.0 mg/L Mar-Nov: 0.1-2.2 mg/L
Coldwater habitat	0.5-13.0 mg/L	0.1-2.5 mg/L
Seasonal salmonid habitat		

The Ohio WQS include criteria for phosphorus. The standards state that where nuisance growths exist, phosphorus discharges shall not exceed 1 mg/L daily average. These requirements may be stricter as determined by the director and in accordance with the international joint commission (Ohio EPA, 2011).

B.37 Oklahoma

The State of Oklahoma currently has narrative nutrient criteria as well as some site-specific numeric nutrient criteria. The WQS state, "In addition to these narrative criteria, there is a numerical criterion for phosphorus on waters designated Scenic Rivers. The criterion states that the 30-day geometric mean TP concentration shall not exceed .037 mg/L in these waters, and that this level will be fully implemented within 10 years."

The state developed a Nutrient Criteria Development Plan in 2006 which provides a long term strategy for nutrient criteria development (Oklahoma Water Resources Board, 2006). The state is focused on first developing criteria for lakes and will follow with the development of criteria for streams.

B.38 Oregon

Oregon has numeric criteria for DO, pH, and chlorophyll-a, and narrative criteria for algal growth which is used to assess nutrient impairments. Waterbody specific TMDLs are used for areas with nutrient impacts.

B.39 Pennsylvania

The Commonwealth of Pennsylvania has not developed statewide numeric nutrient criteria. EPA recommended two approaches to nutrient criteria development focused on empirical methods. The initial draft developed by EPA was appealed by several groups within the state and a review of the EPA Science Advisory Board. Based on a conversation with the State Department of Environmental Protection, the EPA Science Advisory Board ruled with the appellate group and required EPA to redraft the numeric nutrient criteria. EPA recently developed new draft stress-response indicators. However, Pennsylvania is part of the Chesapeake Bay Program described further in this appendix.

B.40 Rhode Island

The basis for numeric nutrient criteria in Rhode Island was initiated in the Plan for Managing Nutrient Loadings to Rhode Island Waters (Rhode Island DEM, 2005). The state currently has criteria for lakes and tributaries that flow into lakes; however, there are no direct dischargers to these systems. The state is in the process of generating new nutrient criteria for lakes and gathering additional data to generate river and estuarine nutrient criteria. The state is evaluating whether the criteria will be strictly nitrogen and phosphorus or if another water quality indicator, like chlorophyll-a or DO, will be used.

The Rhode Island Narragansett Bay nutrient program targets reducing nitrogen. The Rhode Island Department of Environmental Management (DEM) has determined that it would be appropriate to establish seasonal (May through October) WWTF total nitrogen limits that range from 5.0 mg/l to 8.0 mg/l and require operation of all available treatment equipment throughout the rest of the year in order to maximize the benefits of the WWTF improvements. RIGL § 46-12-2(f) required that DEM issue proposed permit modifications by July 1, 2004, to achieve an overall goal of reducing nitrogen loadings from WWTFs by fifty percent by December 31, 2008.

B.41 South Carolina

South Carolina's WQS (R.61-68, 2008) include narrative and numeric nutrient criteria. Narrative criteria prevent discharges of nutrients that would result in growth of microscopic or macroscopic vegetation such that WQS are violated or designated uses impaired, and state that nutrient loadings shall be addressed on an individual basis. Numeric nutrient criteria apply to lakes of 40 acres or more and include ecoregion-based criteria for TP, TN and chlorophyll-a.

The state is also working on numeric criteria for streams, rivers, and estuaries. According to the South Carolina's 2010 nutrient criteria development plan update, the state expects to promulgate numeric criteria for estuaries as part of its 2014 triennial review. Appropriate parameters for the estuary criteria, which may include phosphorus, nitrogen, chlorophyll-a or turbidity, are still being evaluated. For rivers and streams, the state is proposing to develop site-specific numeric criteria based on measures of trophic status and identification of nutrient enrichment, rather than state-wide criteria. The state intends to develop the methodology for site-specific assessments of river and stream trophic status and nutrient enrichment by mid-2014, for the next triennial review, followed by implementation and criteria development.

B.42 South Dakota

South Dakota does not currently have numeric nutrient criteria, and according to the EPA, does not have a plan on file to develop these criteria. At a Nutrient and Water Quality Workshop in EPA Region 8, a summary of nutrient criteria in South Dakota was provided:

Patrick Snyder, Environmental Senior Scientist with the South Dakota Department of Environment and Natural Resources (DENR), reported that the department has been relying on written narrative standards for nutrients as well as a rule that prohibits point source discharges directly to lakes instead of establishing nutrient criteria. South Dakota is not planning on adopting nutrient criteria with any urgency in the near future. Patrick stated that, "while we will not be adopting numeric nutrient criteria anytime soon, South Dakota is addressing nutrient issues within the state." (http://www.cwi.colostate.edu/publications/is/111.pdf)

B.43 Tennessee

The State of Tennessee WQS currently includes narrative nutrient criteria.

B.44 Texas

As part of the EPA "National Strategy for the Development of Regional Nutrient Criteria" (USEPA, 1998), the Texas Commission on Environmental Quality (TCEQ) has been working for more than a decade to develop nutrient standards for Texas. To include stakeholder involvement during the development process, a Nutrient Criteria Development Advisory Work Group (NCDAWG) was established. The NCDAWG is an open participation, voluntary group that provides guidance and information on options for developing nutrient criteria including strategies for developing criteria, types of criteria, categorization of waterbodies, and any additional data needs.

The TCEQ developed the "Nutrient Criteria Development Work Plan for the State of Texas" (TCEQ, 2006) and submitted to EPA in 2006. The purpose of this draft plan was to provide a framework for developing nutrient WQS. The actual WQS are published in the Texas Surface WQS (30 TAC, Chapter 307), which is updated triennially. In conjunction with the Texas Surface WQS (Standards) revisions, TCEQ has a document "Procedures to Implement the Texas Surface WQS" (RG-194), which is commonly referred to as the Implementation Procedures (IP).

Nutrient controls, historically, have been enacted by TCEQ through narrative criteria, watershed rules, and antidegradation considerations. Areas of possible concern are identified in the biennial Integrated Report on Water Quality in Texas, more commonly known as the 303d listing of impaired waterbodies. For this report, TCEQ screens for phosphorus, nitrate nitrogen, and chlorophyll monitoring data as a preliminary indication.

The TCEQ is developing numeric nutrient criteria in the following order: reservoirs, streams and rivers, and estuaries. The 2010 revisions to the Standards (TCEQ, 2010) included adopted numerical nutrient criteria for 75 major reservoirs. Concurrently, the screening procedures for nutrients were revised in the IP and approved. Two options were considered during development of the numeric nutrient criteria for reservoirs only. Under Option 1, a water body was considered impaired if Chlorophyll-a criteria plus one of the screening values was exceeded. TCEQ defined TP and Secchi depth screening values for each reservoir. Option 2 only considered Chlorophyll-a criteria. Option 2 was adopted in the 2010 Standards. The 2010 Standards and IP were submitted to EPA Region 6 for review and approval in August 2010. In July 2013, EPA Region 6 provided a letter to TCEQ addressing Texas' revision of the WQS submitted in 2010. The EPA reviewed and acted on numeric reservoir criteria found in Appendix F by approving 39 and disapproving 36 adopted numeric criteria. In addition, the EPA provided a TSD detailing their decision making process. The EPA stated that "chlorophyll-a, the primary photosynthetic pigment in phytoplankton, is among the four water quality parameters EPA has recommended that states adopt into WQS" (EPA Region 6, 2013a, 2013b).

TCEQ, with participation from the NCDAWG through email and workshops, is in the process of developing numeric nutrient criteria for streams and rivers. Two options are currently under consideration. Option 1 is to base numeric criteria on historical nutrient levels in reference streams and rivers. Option 2 is a stressor/response analyses relating TN and TP to biological indices, DO, and Chlorophyll-a in rivers and attached algae in smaller streams. The challenges that Texas is facing are: limited data for TN and relative abundance of attached algae: extensive geographic, hydrologic, and chemical variability across the state making it difficult to categorize and group waterbodies; and how to address nutrients in effluent dominated streams. TCEQ has indicated that numeric criteria for rivers and streams will not be included in the 2013 Standards.

B.45 Utah

Approximately 80 percent of the point source dischargers in Utah are located along the Wasatch Front. The wastewater treatment plants discharge into Utah Lake, the Jordan River, or the Farmington Bay quadrant of the Great Salt Lake. Numeric nutrient criteria have not been developed for these waterbodies.

The Jordan River Farmington Bay Water Quality Coalition, a partnership of the Wasatch Front wastewater treatment plants, developed a strategy for establishing nutrient criteria across the state. The Coalition developed several guiding principals to be used in the development of the implementation document for nutrient criteria. One of the criteria requires balancing nutrient reductions between point and nonpoint sources. "Point sources should be regulated to a technically achievable economic end point not limits of technology." Suggested effluent nutrient limits are 1 mg/L TP and 15 to 20 mg/L total inorganic nitrogen. The anticipated schedule, as developed by the Coalition, provides until 2020 to complete the nutrient criteria development and until 2030 to implement the criteria into the NPDES permits. It is unclear if this schedule will be maintained, or if a more accelerated schedule will be required by EPA Region 8 or Utah DEQ.

B.46 Vermont

Vermont does not have statewide numeric nutrient criteria at this time. The state WQS include site-specific TP standards for lakes, bays, and upland streams. The Lake Champlain Basin includes a maximum mean phosphorus effluent concentration for POTWs of 0.8 mg/L. There are no statewide TN limits but there are nitrate criteria that range from 2.0 to 5.0 mg/L.

B.47 Virginia

In addition to the Chesapeake Bay nutrient program, Virginia is engaged in developing fresh water nutrient criteria for lakes and reservoirs and free-flowing streams.

Numeric chlorophyll-a and TP criteria for man-made lakes and reservoirs were established in 2007. The lakes and reservoir criteria are used in conjunction with biological assessments in determining designated use attainment or impairment: if the numeric criteria are exceeded, the status of the fishery is assessed before a determination of designated use impairment is made and if adjustments to the site-specific criteria are appropriate.

Regarding stream nutrient criteria, Virginia has established numeric chlorophyll-a criteria for the tidal James River as part of the state's Chesapeake Bay program. Chesapeake Bay TMDL WLAs for James River dischargers are based in part on meeting the in-stream criteria. An in-depth re-evaluation of the James River chlorophyll-a criteria is included in Virginia's WIP and is currently underway to determine if the existing criteria are appropriate or should be revised. The re-evaluation includes an extensive monitoring program, an examination of linkages between chlorophyll-a and harmful algal blooms, and development of a James River-specific water quality model. The James River evaluation is scheduled for completion by 2017.

Virginia is also working on the development of numeric criteria for other freshwater streams and rivers and has formed an Academic Advisory Committee (AAC) to evaluate and recommend appropriate alternatives. Most of the work of the AAC to date has concentrated on wadeable streams. In their 2012 report on wadeable streams, the AAC recommended a screening approach as an alternative to single fixed numeric concentrations. The screening approach would first apply threshold concentrations, including no observed effect concentrations and observed effect concentrations for in stream TN and TP to assess the probability of nutrient impairment based on in stream concentrations alone. If in stream concentrations suggest a probability of impairment, visual assessment followed by a benthic macroinvertabrate survey would be performed to make a final determination of impairment. Work to date on non-wadeable streams and rivers has included studies of the response of fish communities to nutrient concentrations and trophic status. The state is currently reviewing the AAC recommendations and data analyses and adjustments to the overall nutrient criteria development plan, and any initiation of a nutrient criteria rulemaking before 2014 at the earliest is unlikely.

Virginia has identified nutrient impairment as a factor in non-attainment of aquatic life uses in 303(d)-listed waters located both in and out of the Chesapeake Bay watershed. Current state regulations require a 2 mg/L TP monthly average limit in permits for wastewater treatment plants discharging to nutrient enriched waters, unless a lower limit is required to meet TMDL WLAs.

B.48 Washington

The Washington Department of Ecology (DOE) has historically used TMDLs to develop site-specific nutrient criteria. Typically, substantial analysis is incorporated into the policy and permitting on a site-by-site basis. One key wastewater treatment initiative in western Washington is focused on Puget Sound water quality and nitrogen removal. Phosphorus is not the current primary concern in marine waters.

The state has also adopted phosphorus criteria for lakes which are outlined in the EPA-approved document “Nutrient Criteria Development in Washington State: phosphorus” (DOE, 2004).

B.49 West Virginia

West Virginia is West Virginia’s WQS (2011) include numeric nutrient criteria for cool and warm water lakes expressed as TP and chlorophyll-a concentrations. Both criteria need to be exceeded for a lake to be classified as impaired. Numeric criteria for rivers and streams are also being evaluated; however, the status of river and stream criteria development is unknown. West Virginia is part of the Chesapeake Bay Program described further in this appendix.

B.50 Wisconsin

The State of Wisconsin is in the process of developing water quality criteria for phosphorus. The development of these phosphorus criteria are identified as an item of “Group A: Revisions/Development Currently in Progress” for the 2008-2011 Triennial Standards Review Cycle (DNR, 2010a). While the State does not have nitrogen on the priority list, nitrogen is also expected to require examination. Wisconsin may implement nutrient standards in the next few years through either the State rulemaking process, or potentially as promulgated by EPA as part of a Gulf of Mexico nutrient reduction plan.

The State of Wisconsin DNR and the United States Geological Survey (USGS) have completed numerous water quality studies in Wisconsin. USGS studies include investigation of the relationships between nutrient concentrations and the biotic integrity of nonwadeable rivers and wadeable streams (USGS, 2006, USGS, 2008). This extensive knowledge of water quality, along with the DNR's water quality monitoring database, the Surface Water Integrated Monitoring System (SWIMS), have been cited as the basis for water quality impairment. The Wisconsin 2010 303(d) list includes 1,216 individual 303(d) listings for 523 waterbodies (DNR, 2010b).

The DNR formed a technical advisory committee to assist with development of phosphorus criteria and to review draft rules for nutrient standards. The phosphorus criteria developed for streams is 0.075 mg/L and for rivers is 0.100 mg/L (Wisconsin Adm. Code, NR 102.06). The phosphorus criteria developed for lakes and reservoirs varies from 0.015 mg/L to 0.40 mg/L depending upon stratification and drainage characteristics (Wisconsin Adm. Code, NR 102.06). The criteria are based on studies completed on Wisconsin waterbodies, along with scientific concepts for river and lake water quality (Clean Water, 2008). The proposed draft rules are incorporated in NR 217, Effluent Standards and Limitations for Phosphorus and NR 106 procedures for calculating water quality based effluent limitations for toxic and organoleptic substances discharged to surface waters (DNR, 2011).

In late 2009, a coalition of environmental groups announced their intent to sue EPA to promulgate numeric nutrient criteria for phosphorus and nitrogen for the State of Wisconsin (MEA, 2009a, MEA, 2009b). The group stated the need to accelerate the process and enact standards. The group also stated that the DNR has developed the science needed for sound phosphorus standards. The notice of intent to sue includes, "*DNR has yet to propose that its governing board, the Natural Resources Board, amend the Wisconsin Administrative Code to include numeric criteria for phosphorus. DNR does not expect to begin promulgation of numeric nitrogen water quality criteria until at least 2012. In the meantime DNR refuses to derive water quality based effluent limits in NPDES permits to implement its narrative standard as applied to nitrogen and phosphorus*" (MEA, 2009b).

The water quality based effluent limits will be calculated and must be implemented by the third permit term. The effluent phosphorus limits in the first permit term are 0.6 mg/L as a six month average and 1.0 mg/L as a monthly average. The effluent phosphorus limits in the second permit term are 0.5 mg/L as a six month average and 1.0 mg/L as a monthly average. The WQBEL that is calculated initially will be reevaluated if water quality improves (WNDR, 2012).

B.51 Wyoming

Currently, Wyoming does not have numeric nutrient criteria. In 2008, Wyoming published a plan for implementing nutrient criteria, and according to the plan, Wyoming will propose numeric nutrient criteria sometime between 2013 and 2015.

B.52 Chesapeake Bay (Pennsylvania, Maryland, Virginia, DC, New York, Delaware, West Virginia)

The Chesapeake Bay TMDL is the largest ever developed by EPA, encompassing a 64,000 square mile watershed and large parts of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia (EPA, 2010a). The Chesapeake Bay TMDL was developed to address impairment of aquatic life uses, including seasonal hypoxia, algae blooms, and diminished water clarify, due to excessive nitrogen, phosphorus, and sediment loadings. Specifically, the TMDL calls for a reduction in nitrogen, phosphorus, and sediment of 25%, 24%, and 20%, respectively. The allowable loads are divided among the dischargers based on "state of the art modeling tools, extensive monitoring data, peer-reviewed science, and close interaction with jurisdiction partners" (EPA, 2010a).

The TMDL loadings to the states and District of Columbia and the associated river basins are shown in Table B-15 (EPA, 2010a). TMDL loadings are further disaggregated into wasteload and load allocations for point and non-point load sectors, respectively, in accordance with WIP prepared by the states and District of Columbia. WLAs for the wastewater treatment sector in most cases were broken down into individual WLAs assigned to individual wastewater treatment facilities and in some cases aggregate WLAs covering multiple facilities. The states and District of Columbia will incorporate wastewater treatment sector WLAs into their NPDES permitting program. NPDES permitting strategies are described in the various WIPs and are summarized for each jurisdiction in the following subsections.

Table B-15. Chesapeake Bay TMDL Watershed Nitrogen, Phosphorus and Sediment Final Allocations by Jurisdiction and by Major River Basin

(EPA, 2010a).

Chesapeake Bay Watershed Proposed Revised Target Nitrogen and Phosphorus Allocations by Jurisdiction		
Jurisdiction/Basin	Nitrogen Allocation (million pounds per year)	Phosphorus Allocation (million pounds per year)
PENNSYLVANIA		
Susquehanna	73.12	3.06
Potomac	3.74	0.44
Eastern Shore	0.31	0.02
Western Shore	0.03	0.002
PA Total	77.20	3.52
MARYLAND		
Susquehanna	1.16	0.06
Eastern Shore	11.50	0.99
Western Shore	9.36	0.52
Patuxent	3.00	0.23
Potomac	14.77	0.91
MD Total	39.79	2.71
VIRGINIA		
Eastern Shore	1.36	0.14
Potomac	16.04	1.74
Rappahannock	5.76	0.89
York	5.38	0.60
James	23.21	2.94
VA Total	51.75	6.31
DISTRICT OF COLUMBIA		
Potomac	2.29	0.11
DC Total	2.29	0.11
NEW YORK		
Susquehanna	8.07	0.63
NY Total	8.07	0.63
DELAWARE		
Eastern Shore	3.30	0.27
DE Total	3.30	0.27
WEST VIRGINIA		
Potomac	4.82	0.61
James	0.02	0.01
WV Total	4.84	0.62
Total Basin/Jurisdiction Draft Allocation	**187.25**	**14.16**
Atmospheric Deposition Draft Allocation	**15.70**	**--**
Total Basinwide Draft Allocation	**202.95**	**14.16**

B.53.1 Virginia

Virginia established individual WLAs for nitrogen and phosphorus for significant point source dischargers to the Chesapeake Bay and its tributaries in their 2005 Tributary Strategies and accompanying Water Quality Management Planning Regulation. Significant dischargers included facilities with permitted flows of 0.1 mgd or more that discharge to tidal waters and facilities with permitted flows of 0.5 mgd or more located above the fall line. Nutrient WLAs expressed as annual mass loadings are implemented via the state's Chesapeake Bay Nutrient Watershed General Permit. The first General Permit was effective from January 1, 2007, through December 31, 2011, and required compliance with the annual mass loading limits for calendar year 2011. The reissued General Permit became effective on January 1, 2012, and is effective through December 31, 2016. The Chesapeake Bay TMDL WLAs are consistent with the Virginia Tributary strategies for most dischargers, with the exception of reduced nitrogen WLAs in the TMDL for dischargers in the York River and Lower James River Basin. WLAs for significant dischargers are equivalent to effluent concentrations ranging from 3 mg/L to approximately 10 mg/l TN and 0.3 mg/l to 1 mg/L TP, depending on the river basin.

While mass loadings are covered in the General Permit, technology-based annual average effluent limits for TN and TP may also be included in individual VPDES permits based on design performance of the installed nutrient removal process.

Non-significant facilities with individual VPDES permits are also covered under the Watershed General Permit. Nutrient loadings from non-significant facilities are set at the 2005 permitted capacities and are equivalent to effluent concentrations of 18.7 mg/l TN and 2.5 mg/L TP. New or expanded facilities of 0.4 mgd or more must install nutrient removal technology and obtain offsets for the entire amount of increased nutrient loadings from the new or expanded facility.

The General Permit regulation also established a nutrient trading program open to all dischargers regulated under the General Permit. The Virginia Nutrient Credit Exchange Association in collaboration with participating owners has also developed an Exchange Compliance Plan to promote nutrient trading between permitted entities discharging to the Chesapeake Bay Watershed. The program assists participants with meeting aggressive WLAs set for by the Chesapeake TMDL and Virginia DEQ General VPDES watershed permits. The initial focus of the exchange is on the construction of nutrient removal technology upgrades at participant facilities. Long-term focus is on maintaining compliance in the watersheds.

B.53.2 Delaware

The Delaware Department of Natural Resources and Environmental Control (DNREC) had previously developed TMDLs for impaired waterways in the states jurisdiction that did not meet Delaware's WQS. Currently, three significant municipal facilities (permitted flows of 0.4 mgd or more) in the Chesapeake watershed are permitted at 5.6-8mg/L TN and 1.43-2mg/L TP based on the nitrogen and phosphorus TMDLs established for the Nanticoke River. As part of the Delaware WIP the Surface Water Discharge Section will require effluent concentrations of 4 mg/L for TN and 1.0 mg/L for TP for these significant POTWs (permitted flow of 0.4 mgd or more) located within the state's Chesapeake Bay watershed; these requirements will be implemented in the next permit cycle. WIP nutrient WLAs for a 60,000 gpd non-significant

POTW in the Bay watershed are set at current baseline permitted loads per the Nanticoke River TMDL.

B.53.3 Maryland

The State of Maryland adopted a point source cap policy as part of the 2004 Tributary Strategy. This policy calls for essentially "Limit of Technology" discharge concentrations of 4 mg/L TN and 0.3 mg/L TP for major municipal wastewater treatment plants (permitted capacity of 0.5 mgd or higher) enforced through NPDES permits. At the time of Maryland's Phase II WIP, 23 of 67 major POTWs had been upgraded to enhanced nutrient removal. Maryland expects upgrades to be completed at the remaining major facilities by 2017.

Maryland's Tributary Strategy and WIP include annual nutrient load goals for minor municipal wastewater treatment facilities (permitted capacity less than 0.5 mgd) based on design flow or projected 2020 flow, whichever is lower, and effluent nutrient concentrations of 18 mg/L TN and 3 mg/L TP. Minor plants that expand will be subject to load caps based on the enhanced nutrient removal standard. Starting in 2014, the state also plans to evaluate the feasibility and cost effectiveness of upgrading five to ten minor treatment plants, based on additional nitrogen reduction, to enhanced nutrient removal.

B.53.4 Pennsylvania

Nutrient loads from significant point source discharges (design annual average flow of 0.4 mgd or higher) presented in Pennsylvania's WIP are based on previous work presented in the 2006 *Chesapeake Bay Point Source Compliance Strategy* and summarized in the Pennsylvania Chesapeake Bay Watershed Implementation Plan – Phase 1 (Pennsylvania DEP, 2011a). Individual WLAs for significant point source dischargers were implemented as cap loads into NPDES permits beginning in October 1, 2010. The cap loads are based on concentrations of 6.0 mg/L TN and 0.8 mg/L TP at 2005 design annual average daily flow. At the time of Pennsylvania's Phase 2 WIP (Pennsylvania DEP, 2012), permits including nutrient cap loads and compliance schedules were reissued for 180 out of a total 190 significant dischargers. Dischargers proposing to expand the capacity of facilities beyond the 2005 design flow are held to the nutrient load cap established in the original NPDES. The WIP makes allowances for eleven municipal dischargers that voluntarily achieve loads equivalent to 8.0 mg/L TN and 1.0 g/L TP at the 2010 flows; the state does not require these dischargers to achieve the lower cap loads.

Pennsylvania's WIP includes aggregate nutrient WLAs for non-significant facilities. The state will include nutrient monitoring requirements but does not expect to include cap loads in permits for non-significant facilities that do not increase their annual average design capacity. Renewed or reissued permits for an increase design flow at non-significant facilities will include cap loads equal to 6 mg/L TN and 0.8 mg/L TP at 0.4 mgd.

The nutrient loads were enforced through individual NPDES permits and watershed-based NPDES permits. As wastewater flows increase, the equivalent allowable effluent concentration will decrease to maintain the permitted load for each facility. The WIP does not account for growth, rather a "no net nutrient increase" strategy applies (Pennsylvania DEP, 2011b). New industrial and domestic point sources will be assigned a zero nutrient load for the Chesapeake Bay to maintain no nutrient increase. Dischargers can find credits, offsets, or participate in trading to maintain NPDES compliance.

The Pennsylvania DEP operates a market based nutrient trading program to provide alternatives for NPDES permittees to meet effluent limits for nutrients. It is a voluntary program open to point and non-point sources, in the Susquehanna and Potomac watersheds.

B.53.5 West Virginia

In 2005 West Virginia DEP published the *West Virginia Potomac Tributary Strategy* that established individual WLAs for significant dischargers (flows equal to or greater than 0.4 mgd) based on permitted flow and effluent concentrations of 5 mg/L for TN and 0.5mg/L for TP. Similar individual WLAs also apply to a small number of insignificant dischargers for which initial permits were issued after the tributary strategies were established. The tributary strategy WLAs are consistent with the nutrient load allocations set forth in the Bay TMDL. Mass load limits are included in individual NPDES permits for facilities subject to individual WLAs.

Nutrient loadings from existing non-significant dischargers (less than 0.4 mgd) are held at existing loads. Existing loads are established using a 2010 modeling scenario based on permitted flow and effluent concentrations of 18 mg/L TN and 3 mg/L TP. Nutrient loads for individual facilities are aggregated at the county level into grouped annual average WLAs expressed as lb/year. Most non-significant facilities have permitted flows of 50,000 gpd or less and are covered under General Permits. Compliance is assessed at time of permit reissuance by verifying that group WLAs have been met.

West Virginia's strategy does not include additional WLAs allowances for growth from wastewater treatment facilities of any size. 100 percent offsets of new loads with enforceable permit conditions requiring offsets are required for new or expanded facilities.

B.53.6 New York

New York's 2006 Tributary Strategy for Chesapeake Bay Restoration includes a staged approach to address nutrient loads from 28 Bay-significant (permitted flow of 0.4 mgd and higher) wastewater treatment facilities. As of 2011, New York SPDES permits for 24 of 28 Bay-significant dischargers have been modified to require nutrient monitoring, nutrient removal optimization with a goal of achieving discharge nutrient concentrations of 12 mg/L TN and 2 mg/L TP, and engineering evaluations for achieving additional nutrient reduction.

New York is proposing a phased approach to permitting and WLAs to meet the Chesapeake Bay nutrient TMDL load targets for Bay-significant dischargers. The state is concentrating first on 2017 interim nutrient reduction targets per the TMDL, proposing phosphorus limits based on chemical phosphorus removal performance in conjunction with nitrogen removal improvements at large municipal and several industrial wastewater treatment facilities. Individual phosphorus limits are anticipated based on meeting local water quality, with "bubbling" allowed for owners of multiple facilities in the same stream reach. An aggregate WLA and a "bubble" permit approach are proposed for nitrogen.

New York is also considering a phosphorus-nitrogen exchange provision in which an individual facility that discharges less phosphorus than allowed in their WLA would be able to get additional nitrogen WLA based on a site-specific nitrogen to phosphorus ratio.

For non-significant dischargers, which account for less than 4 percent of nutrient loadings from wastewater treatment facilities, the state is incorporating nitrogen and phosphorus monitoring requirements into SPDES permits to verify that annual loads are within the wasteload allowance for these smaller facilities.

B.53.7 District of Columbia

The District of Columbia's Blue Plains wastewater treatment facility, which serves separate and combined sewer systems in the District as well as parts of Virginia and Maryland, has a nutrient removal treatment capacity of 370 mgd and a peak capacity of 1,076. Chesapeake Bay TMDL WLAs for Blue Plains were incorporated into the facilities NPDES permit in 2010. TMDL-based permit limits include a monthly average phosphorus limit of 0.18 mg/L and an annual mass load limit for TN, equivalent to 3.9 mg/L TN at the 370 mgd nutrient removal capacity, for the main plant outfall. A TN WLA has also been set aside for the wet weather outfall, for which phosphorus and nitrogen monitoring is required when the outfall is active during wet weather events.

B.54 Summary

There are four states with statewide numeric nutrient criteria in place, although not all of these states have implemented the standards into NPDES permits. There are ten states that have some site-specific numeric nutrient criteria and are in varying stages of developing statewide criteria. Twelve states are in the process of evaluating or developing statewide numeric nutrient criteria. The remaining states (approximately half) have either developed a nutrient reduction plan, are in the process of developing a nutrient reduction plan, or have not initiated statewide numeric nutrient criteria development in any form.

The implementation strategies often identify how the NPDES permits should be structured, moving away from monthly and weekly averages, and including provisions for longer averaging periods and load based effluent limits.

APPENDIX C

SELECT NUTRIENT NPDES PERMITS BY STATE

This appendix provides a reference source for effluent discharge permits for nutrients by state. Where available, an NPDES permit was selected from each state to represent the current discharge permitting practice and illustrate the structure of the permits in use. An effort was made to select the most interesting permit from the standpoint of nutrients. Not all states have issued NPDES permits with nutrient limits, therefore the entries for some states are limited. In some cases permits with ammonia limits are included in states where nitrogen and phosphorus limits were not included.

The effluent limits tables from example permits are included as they appear in the NPDES permits themselves, without re-formatting or otherwise editing their appearance. This was done intentionally in order to illustrate the structure and variety of effluent limits across the nation.

C.1 Alabama

The Helena Wastewater Treatment Plant located south of Birmingham in the Helena, Alabama was issued a permit to discharge to Buck Creek. The permit AL0023116 expires on January 31, 2017. The permit was issued by the Alabama Department of Environmental Management (DEM). The flow is based on a design flow of 4.95 mgd. The effluent limitations table from the permit is shown in Figure C-1.

Helena, Alabama, was recently issued an updated NPDES permit with effluent limitations to meet the Cahaba River TMDL. The permit includes monthly and weekly concentration and load limits for ammonia and TKN and a growing season (April through October) monthly average phosphorus limit of 0.043 mg/L. A ten-year compliance schedule to meet the phosphorus limit is also included in the permit. The Nutrient TMDL for the Cahaba River Watershed includes a growing season median TP target in-stream concentration of 0.035 mg/L (Alabama DEM, 2006). This permit was selected because of the effluent phosphorus limits below 0.05 mg/L.

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PART I **DISCHARGE LIMITATIONS, CONDITIONS, AND REQUIREMENTS**

A. DISCHARGE LIMITATIONS AND MONITORING REQUIREMENTS

1. Outfall 0012 Discharge Limits

During the period beginning on the effective date of this permit and lasting through the expiration date of this permit, the Permittee is authorized to discharge from Outfall 0012, which is described more fully in the Permittee's application. Such discharge shall be limited and monitored by the Permittee as specified below:

	Discharge Limitations*							Monitoring Requirements**			
Parameter	Monthly Average	Weekly Average	Monthly Average	Weekly Average	Daily Minimum	Daily Maximum	Percent Removal	(1) Sample Location	(2) Sample Type	(3) Measurement Frequency	(4) Seasonal
Oxygen, Dissolved (DO) 00300 1 0 0	*****	*****	*****	*****	6.5 mg/l	*****	*****	E	GRAB	C	S
Oxygen, Dissolved (DO) 00300 1 0 0	*****	*****	*****	*****	6.0 mg/l	*****	*****	E	GRAB	C	W
pH 00400 1 0 0	*****	*****	*****	*****	6.0 S.U.	8.5 S.U.	*****	E	GRAB	C	*****
Solids, Total Suspended 00530 G 0 0	REPORT lbs/day	REPORT lbs/day	REPORT mg/l	REPORT mg/l	*****	*****	*****	I	COMP24	C	*****
Solids, Total Suspended 00530 1 0 0	1238 lbs/day	1857 lbs/day	30.0 mg/l	45.0 mg/l	*****	*****	*****	E	COMP24	C	*****
Ammonia, Total (As N) 00610 1 0 0	20.6 lbs/day	30.9 lbs/day	0.5 mg/l	0.7 mg/l	*****	*****	*****	E	COMP24	C	S
Ammonia, Total (As N) 00610 1 0 0	28.8 lbs/day	43.3 lbs/day	0.7 mg/l	1.0 mg/l	*****	*****	*****	E	COMP24	C	W
Nitrogen, Total Kjeldahl 00625 1 0 0	61.9 lbs/day	92.8 lbs/day	1.5 mg/l	2.2 mg/l	*****	*****	*****	E	COMP24	C	S
Nitrogen, Total Kjeldahl 00625 1 0 0	70.1 lbs/day	105 lbs/day	1.7 mg/l	2.5 mg/l	*****	*****	*****	E	COMP24	C	W
Nitrite Plus Nitrate, Total (As N) 00630 1 0 0	REPORT lbs/day	REPORT lbs/day	REPORT mg/l	REPORT mg/l	*****	*****	*****	E	COMP24	G	*****
Phosphorus, Total 00665 1 0 0	REPORT lbs/day	REPORT lbs/day	See Note (TP)	REPORT mg/l	*****	*****	*****	E	COMP24	C	GS
Phosphorus, Total 00665 1 0 0	REPORT lbs/day	REPORT lbs/day	REPORT mg/l	REPORT mg/l	*****	*****	*****	E	COMP24	C	NGS

* See Part II.C.1. (Bypass); Part II.C.2. (Upset)
** Monitoring Requirements

(1) Sample Location
I – Influent
E – Effluent
X – End Chlorine Contact Chamber
K - Percent Removal of the Monthly Avg. Influent Concentration from the Monthly Avg. Effluent Concentration.
RS - Receiving Stream

(2) Sample Type:
CONTIN - Continuous
INSTAN - Instantaneous
COMP-8 - 8-Hour Composite
COMP24 - 24-Hour Composite
GRAB – Grab
CALCTD - Calculated

(3) Measurement Frequency: See also Part I.B.2.
A - 7 days per week
B - 5 days per week
C - 3 days per week
D - 2 days per week
E - 1 day per week
F - 2 days per month
G - 1 day per month
H - 1 day per quarter
J - Annual
Q - For Effluent Toxicity Testing, see Provision IV.B.

(4) Seasonal Limits:
S = Summer (May – November)
W = Winter (December - April)
GS = Growing Season (April – October)
NGS = Non-Growing Season (November – March)
PS = Pathogen Summer (June – September)
PW = Pathogen Winter (October – May)

(TP) From the permit effective date through March 31, 2014 – Growing season monthly average limit = 2.1 mg/L
From April 1, 2014 through March 31, 2022 – Growing season monthly average limit = 0.2 mg/L
From April 1, 2022 forward – Growing season monthly average limit = 0.043 mg/L
For complete schedule, see Part I.E.2

Figure C-1. Helena Wastewater Treatment Plant Discharge Limitations, Conditions, and Requirements.

C.2 Alaska

Palmer Wastewater Treatment Plant located northeast of Anchorage in Palmer, Alaska was issued a permit to discharge to the Matanuska River. The permit AK-002249-7 expired on December 31, 2011. The permit was issued by the US EPA, Region 10. The flow is based on a design flow of 0.95 mgd. The effluent limitations table from the permit is shown in Figure C-2.

Ammonia criteria in Alaska are driven by the protection of aquatic life in receiving waters, specifically the early life stages of salmonids. The City of Palmer received new, low effluent ammonia limits in 2007 to protect the receiving water quality. The permit limits decreased from 34 mg/L to 1.7 mg/L (summer) and 8.7 mg/L (non-summer season). A 4-year 11-month compliance schedule was included to allow the City of Palmer to meet these new stringent limits. The NPDES permit includes average monthly and maximum daily concentration and load limits for ammonia, with the lowest limits in July and August.

Table 1. Effluent and Influent Limits and Monitoring Requirements

Parameter	Units	Effluent and Influent Limits			Monitoring Requirements		
		Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit	Monitoring Location	Monitoring Frequency	Sample Type
Ammonia (as N)[1]	mg/L	8.7	---	18.5	effluent	1/week	grab
	lbs/day	68.9	---	146.6			
Ammonia (as N)[1] (July & August)	mg/L	1.7	---	3.6	effluent	1/week	grab
	lbs/day	13.5	---	28.5			
BOD_5	mg/L	30	45	60	effluent and influent	1/week	24-hour timed composite
	lbs/day	258	357	475			
	% Removal	See I.B.3.					
DO	mg/L	≥2 at all times			effluent	1/month	grab
Fecal Coliform Bacteria [1]	FC/100 mL	100[2]	---	200	effluent	1/week	grab
Fecal Coliform Bacteria [1] (July & August)	FC/100 mL	20[2]	---	40	effluent	1/week	grab
Flow	mgd	---	---	0.95	effluent or influent	continuous	recording
pH	s.u.	6.5-8.5 at all times			effluent	5/week	grab
TSS	mg/L	30	45	60	effluent and influent	1/week	24-hour timed composite
	lbs/day	258	357	475			
	% Removal	See Part I.B.3.					
Residue [5]	---	See Part I.B.2.			effluent	1/week	visual
Petroleum Hydrocarbons [5]	---	See Part I.B.2.			effluent	1/week	visual
Total Residual Chlorine [1,3]	µg/L	1.7	---	3.4	effluent	2/week	grab
	lbs/day	0.013	---	0.027			
Temperature	C°	---	---	---	effluent	5/week	grab
Whole Effluent Toxicity	TU_C	---	---	---	effluent	3x/5 years [4]	grab

Figure C-2. Palmer Wastewater Treatment Plant Effluent and Influent Limits and Monitoring Requirements.

C.3 Arizona

The Northern Gila County Sanitary District American Gulch Water Reclamation Facility (WRF) located in the Payson, Arizona was issued a permit to discharge to American Gulch in the Verde River Basin. The permit AZ0020117 expires on March 20, 2017. The permit was issued by the Arizona DEQ. The flow is based on a design flow of 2.2 mgd. The effluent limitations table from the permit is shown in Figure C-3.

The Northern Gila County Sanitary District – American Gulch WRF NPDES permit includes effluent limits for both TN and TP. The permit limits are the same as the water quality criteria, monthly average and daily maximum TN concentrations of 1.0 mg/L and 3.0 mg/L, respectively. The TP limitations are monthly average and daily maximum concentrations of 0.1 mg/L and 1.0 mg/L, respectively. The permit includes a variance which allows for effluent discharge greater than the effluent permit limits.

This permit was selected because it highlights the use of variances in the State of Arizona. NPDES permits in Arizona include variances for wastewater treatment plants that cannot meet the low effluent nutrient limits. The Arizona WQS include an annual mean or 90th

percentile limitation rather than a monthly or weekly average however the NPDES permits can include monthly average concentration and load limits as well.

TABLE 1: Effluent Limitations and Monitoring Requirements for Outfall 001 and Outfall 008

Parameter	Maximum Allowable Discharge Limitations						Monitoring Requirement (4) (8)	
	Mass Limits (9)			Concentration Limits				
	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Monitoring Frequency	Sample Type
Discharge Flow (MGD)	REPORT (1)	---	REPORT	---	---	---	Continuous	Metered
Biochemical Oxygen Demand (BOD) (5-day)	250 kg/day	375 kg/day	---	30 mg/L	45 mg/L	---	2x /month	24-hour Composite (5)
BOD (2)	---	---	---	85% REMOVAL MINIMUM	---	---	2x /month	24-hour Composite
Total Suspended Solids (TSS)	250 kg/day	375 kg/day	---	30 mg/L	45 mg/L	---	2x /month	24-hour Composite
TSS (2)	---	---	---	85% REMOVAL MINIMUM	---	--	2x /month	24-hour Composite
E. coli (3)	---	---	---	126 cfu/100 mL (3)	---	575 cfu/100 mL(3)	4X /month	Discrete
Oil & grease	---	---	---	10 mg/L	---	15 mg/L	1x /quarter	Discrete
Chlorine, Total Residual (6) (7)	68 g/day	---	137 g/day	9.0 ug/L	---	18 ug/L	1x /week	Discrete
Chromium VI	60 g/day	---	121 g/day	7.9 ug/L	---	16 ug/L	1x /quarter	Discrete
Cyanide	60 g/day	---	121 g/day	8 ug/L	---	16 ug/L	1x /quarter	Discrete
Lead (10)	35 g/day	---	70 g/day	4.57 ug/L	---	9.18 ug/L	1x /quarter	24-hour Composite
Mercury (12)	0.06 g/day	---	0.12 g/day	0.01 ug/L	---	0.02 ug/L	1x /quarter	Discrete
Selenium	12 g/day	---	25 g/day	2 ug/L	---	3 ug/L	1x /quarter	24-hour Composite
Zinc (10)	993 g/day	---	1663 g/day	131 ug/L	---	219 ug/L	1x /quarter	24-hour Composite
Total Nitrogen (11)	---	---	---	1.0 mg/L (11)	---	3.0 mg/L (11)	1x /every two weeks	24-hour Composite
Total Phosphorus (11)	---	---	---	0.1 mg/L (11)	---	1.0 mg/L (11)	1x /every two weeks	24-hour Composite
Hardness (10)	Report in mg/L.						1x /quarter	24-hour Composite
pH (6)	Not less than 6.5 standard units (S.U.) nor greater than 9.0 S.U.						1x /week	Discrete

(11) These values are the existing standards, however variances have been granted for these parameters and interim limits set. See Part V.A Special Conditions where interim limits are set and reporting is required on Discharge Monitoring Reports (DMRs).

Figure C-3. Northern Gila County Sanitary District Effluent Limitations and Monitoring Requirements for Outfall 001 and Outfall 008.

A. VARIANCE AND INTERIM LIMITS

Variances have been granted for total nitrogen and total phosphorus with interim limits as per the table below. As per A.A.C. R18-11-109.F(1), interim limits for single sample maximum concentrations and annual mean concentrations are set. Data collected as per Table 5 below are to be reported on Discharge Monitoring Reports (DMRs).

Figure C-4. Variance and Interim Limits.

TABLE 5: INTERIM LIMITS for OUTFALLS 001 and 008 (3)

Parameter	Discharge Limitation (mg/L)		Minimum Monitoring Requirement	
	Annual Mean (1)	Single Sample Maximum (2)	Monitoring Frequency	Sample Type
Total Nitrogen	3.53	3.89	1x /month	Discrete
Total Phosphorus	2.52	4.3	1x /month	Discrete

Footnotes:
(1) The annual mean interim limit is calculated as the highest annual mean of the 2009-2010 data plus two standard deviations. [N: 2.64 + (2 x 0.445) = 3.53] [P: 0.92 + (2 X 0.806) = 2.52]
(2) The single sample maximum interim limit is calculated as the highest data point in the 2009-2010 data plus two standard deviations. [N: 3.0 + (2 x 0.445) = 3.89] [P: 2.7 + (2 X 0.806) = 4.3]
(3) Data collected are to be reported on Discharge Monitoring Reports (DMRs).

Figure C-5. Northern Gila County Sanitary District Interim Limits for Outfalls 001 and 008 (3).

C.4 Arkansas

The Berryville Wastewater Treatment Plant located northwest Arkansas in Berryville, AR was issued a permit to discharge to Mill Branch in the White River Basin. The permit AR0021792 expired on November 30, 2012. The permit was issued by the Arkansas DEQ. The flow is based on a design flow of 2.4 mgd. The interim discharge limitations table from the permit is shown in Figure C-6.

The City of Berryville Wastewater Treatment Plant received an updated NPDES permit in 2007 with interim and final ammonia and phosphorus limits. The permit includes interim ammonia limits that vary over two seasons and include monthly average load and concentration limits and a 7-day average concentration limit. The final effluent limits include lower ammonia concentrations over three seasons and effluent phosphorus limits. The ammonia limits in Arkansas are based on either DO effluent limits or toxicity-based standards, whichever are more stringent. The final discharge limitations table from the permit is shown in Figure C-7.

Effluent Characteristics	Discharge Limitations			Monitoring Requirements	
	Mass (lbs/day, unless otherwise specified)	Concentration (mg/l, unless otherwise specified)		Frequency	Sample Type
	Monthly Avg.	Monthly Avg.	7-Day Avg.		
Flow[1]	N/A	Report	Report	Once/day	Totalizing meter
Biochemical Oxygen Demand (BOD5)					
(May-Oct)	300.2	15	22.5	One/week	6-hr composite
(Nov-Apr)	400.3	20	30	One/week	6-hr composite
Total Suspended Solids (TSS)					
(May-Oct)	400.3	20	30	One/week	6-hr composite
(Nov-Apr)	600.5	30	45	One/week	6-hr composite
Ammonia Nitrogen (NH3-N)					
(May-Oct)	40.0	2	3	One/week	6-hr composite
(Nov-Apr)	200.2	10	15	One/week	6-hr composite
Dissolved Oxygen[2]					
(May-Oct)	N/A	5.0 (Monthly Avg. Min.)		Three/week	Grab
(Nov-April)	N/A	Report (Monthly Avg. Min.)		Three/week	Grab
Fecal Coliform Bacteria (FCB)		(colonies/100ml)			
	N/A	1000	2000	One/week	Grab
Total Phosphorus[3]	Report	Report	Report	One/week	6-hr composite
Total Dissolved Solids[4]	Report	Report	Report	One/week	6-hr composite
pH	N/A	Minimum 6.0 s.u.	Maximum 9.0 s.u.	One/week	Grab

Figure C-6. Berryville Wastewater Treatment Plant Interim Limits.

Effluent Characteristics	Discharge Limitations			Monitoring Requirements	
	Mass (lbs/day, unless otherwise specified)	Concentration (mg/l, unless otherwise specified)		Frequency	Sample Type
	Monthly Avg.	Monthly Avg.	7-Day Avg.		
Flow[1]	N/A	Report	Report	Once/day	Totalizing meter
Carbonaceous Biochemical Oxygen Demand (CBOD5)	200.2	10	15	One/week	6-hr composite
Total Suspended Solids (TSS)	300.2	15	22.5	One/week	6-hr composite
Ammonia Nitrogen (NH3-N)					
(April)	32.0	1.6	3.9	One/week	6-hr composite
(May-Oct)	32.0	1.6	3	One/week	6-hr composite
(Nov-March)	80.1	4	6	One/week	6-hr composite
Dissolved Oxygen[2]	N/A	6.0, (Monthly Avg. Min.)		Three/week	Grab
Fecal Coliform Bacteria (FCB)		(colonies/100ml)			
	N/A	1000	2000	One/week	Grab
Total Phosphorus[3]	20.0	1	2	One/week	6-hr composite
Total Dissolved Solids[4]	Report	Report	Report	One/week	6-hr composite
pH	N/A	Minimum 6.0 s.u.	Maximum 9.0 s.u.	One/week	Grab

Figure C-7. Berryville Wastewater Treatment Plant Final Limits.

C.5 California

The Sacramento Regional County Sanitation District Wastewater Treatment Plant located in the Elk Grove, California, was issued a permit to discharge to the Sacramento River. The permit CA0077682 expired on December 1, 2015. The permit was issued by the California Regional Water Quality Control Board. The flow is based on a design flow of 181 mgd. The effluent limitations table from the permit is shown in Figure C-8.

The Sacramento Regional NPDES permit includes average monthly and maximum daily concentration and load limits for ammonia and average monthly concentration for nitrate. A ten-year compliance schedule is included in the permit to achieve the low effluent ammonia limits. Mixing zones for ammonia and nitrate were not allowed in the permit. This permit was selected because it is a large facility that is required to nitrify and denitrify to meet effluent nitrogen limits.

Table 6. Effluent Limitations

Parameter	Units	Effluent Limitations				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
Conventional Pollutants						
Biochemical Oxygen Demand, 5-day @ 20°C[2]	mg/L	10	15	20	–	--
	lbs/day[1]	15,100	22,700	30,200	–	--
Total Suspended Solids[2]	mg/L	10	15	20	–	--
	lbs/day[1]	15,100	22,700	30,200	–	--
pH	standard units	--	--	–	6.0	8.0
Priority Pollutants						
Bis(2-ethylhexyl)phthalate	µg/L	--	–	13	–	--
Carbon Tetrachloride	µg/L	–	–	5.3	–	--
Chlorodibromomethane	µg/L	–	--	2.2	--	--
Copper, Total Recoverable	µg/L	7.3	--	9.3	–	--
Cyanide	µg/L	–	--	11	–	--
Dibenzo(ah)anthracene	µg/L	0.2	–	0.4	–	--
Dichlorobromomethane	µg/L	–	–	3.4	–	--
Methylene Chloride	µg/L	4.7	–	11	–	--
N-nitrosodimethylamine	µg/L	0.00069	–	0.0014	–	--
Pentachlorophenol	µg/L	–	–	18	–	--
Tetrachloroethylene	µg/L	–	–	4.4	–	--
Non-Conventional Pollutants						
Settleable Solids	ml/L	0.1	–	0.2	–	–
Aluminum, Total Recoverable	µg/L	503	--	750	--	--
Ammonia Nitrogen, Total (as N)[2]	mg/L	1.8	–	2.2	–	--
	Lbs/day[1]	2720	--	3320	--	--
Nitrate, Total (as N)	mg/L	10	–	--	–	--
Manganese, Total Recoverable	µg/L	–	--	85	--	--
Methyl Tertiary Butyl Ether	µg/L	–	--	18	--	--

1 Based on a design average dry weather flow of 181 MGD.

2 This Order includes interim effluent limitations for BOD_5, TSS, and Total Ammonia Nitrogen (section IV.A.2.). Effective immediately, the interim effluent limitations shall apply in lieu of final effluent limitations for these constituents. The final effluent limitations for BOD_5, TSS, and Total Ammonia Nitrogen become effective when the Discharger complies with Special Provisions section VI.C.7. or 1 December 2020, whichever is sooner.

Figure C-8. Sacramento Regional County Sanitation District Effluent Limitations.

Table 7. Interim Effluent Limitations

Parameter	Units	Effluent Limitations				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
Conventional Pollutants						
Biochemical Oxygen Demand, 5-day @ 20°C	mg/L	30	45	60	--	--
	lbs/day[1]	45,286	67,929	90,572	--	--
Total Suspended Solids	mg/L	30	45	60	--	--
	lbs/day[1]	45,286	67,929	90,572	--	--
Non-Conventional Pollutant						
Ammonia Nitrogen, Total (as N)	mg/L	33	35	45	--	--
	lbs/day[1]	49,400	52,920	67,929	--	--

1. Based on a design flow of 181 MGD.

Figure C-9. Sacramento Regional County Sanitation District Interim Effluent Limitations.

C.6 Colorado

The Metro Wastewater Reclamation District (MWRD) located in the Denver, Colorado, was issued a permit to discharge to the South Platte River. The permit CO-0026638 expired on February 28, 2013. The permit was issued by Colorado Department of Public Health and Environment. The flow is based on a design flow of 220 mgd. The effluent limitations table from the permit is shown in Figure C-10.

Beginning in 2015, MWRD will have a lower ammonia limit ranging between 2.04 mg/L in August to 4.64 mg/L in December. The 7-day average effluent nitrate limit of 8.68 mg/L must also be met by January 1, 2015. The MWRD permit includes different effluent limits for each month.

The water quality requirements from Regulations 85 and 31 have not yet been applied to NPDES permits in Colorado. The MWRD NPDES permit was issued in January 2008 with effluent ammonia and nitrate limits, requirements that most other facilities in the state have not received yet. MWRD anticipates a TP limit of 0.1 mg/L in the near future.

Effluent Parameter – Continued	30-Day Average	Discharge Limitations Maximum Concentrations 7-Day Average	Daily Maximum
Total Ammonia (as N), mg/l – **Through 12/31/2014**			
January through February	15.0 a/	N/A	30.0 e/
March	14.0 a/	N/A	26.6 e/
April	14.0 a/	N/A	25.6 e/
May	13.0 a/	N/A	25.9 e/
June	13.0 a/	N/A	27.0 e/
July	10.0 a/	N/A	21.5 e/
August	9.7 a/	N/A	23.4 e/
September	10.0 a/	N/A	26.7 e/
October	10.0 a/	N/A	23.4 e/
November	14.0 a/	N/A	24.1 e/
December	15.0 a/	N/A	27.8 e/
Total Ammonia (as N) – **Beginning 1/1/2015**			
January	4.60 a/	N/A	6.31 e/
February	4.47 a/	N/A	6.17 e/
March	4.22 a/	N/A	8.29 e/
April	4.13 a/	N/A	9.21 e/
May	3.08 a/	N/A	11.21 e/
June	2.77 a/	N/A	12.67 e/
July	2.37 a/	2.00 b/	10.37 e/
August	2.04 a/	1.75 b/	10.13 e/
September	2.72 a/	2.23 b/	9.14 e/
October	3.34 a/	N/A	9.18 e/
November	3.54 a/	N/A	7.84 e/
December	4.64 a/	N/A	7.97 e/
Nitrate Plus Nitrite, mg/l as N	N/A	8.68 b/	N/A

Figure C-10. Metro Wastewater Reclamation District Effluent Parameter and Discharge Limitations.

C.7 Connecticut

The Wallingford Water Pollution Control facility, located in southern Connecticut, was issued a permit to discharge to the Quinnipiac River. The permit CT06492 expires on April 24, 2018. The permit was issued by the State of Connecticut Department of Environmental Protection. The flow is based on a design flow of 8 mgd. The effluent limitations table from the permit is shown in Figure C-11.

The Town of Wallingford, Connecticut, operates under an NPDES permit that includes phased effluent phosphorus limits. The 0.7 mg/L TP limit is an average monthly and seasonal average concentration limit that applies from May through October.

Phosphate, Ortho	mg/l	NA	------	Weekly	Daily Composite	NA	NR	NA	DMR/MOR	
Phosphorus (A), Total[5/6], See Remark G April 1st through October 31st November 1st through March 31st	mg/l	------ NA	NA ------	Weekly Monthly	Daily Composite	NA	NR	NA	DMR/MOR	*
Phosphorus (B), Total [7] April 1st through October 31st November 1st through March 31st	mg/l	0.31 NA	0.62 ------	Weekly Monthly	Daily Composite	NA	NR	NA	DMR/MOR	*
Phosphorus, Total April 1st through October 31st November 1st through March 31st	lbs/day	------ NA	NA ------	Weekly Monthly	Daily Composite	NA	NR	NA	MOR	*
Phosphorus (C), Total (Average Seasonal Load Cap) [8] September 30th	lbs/day	8.95	NA	NA	Daily Composite	NA	NA	NA	DMR/MOR	*
Solids, Settleable	ml/l	NA	NA	NA	NA	------	Work Day	Grab	MOR	
Solids, Total Suspended, See remark F	mg/l	30 [1]	50	3/Week	Daily Composite	NA	NA	NA	DMR/MOR	
Temperature	°F	NA	NA	NR	NA	------	Work Day	Grab	MOR	
Turbidity	NTU	NA	NA	NA	NA	------	Work Day	Grab	MOR	
Ultimate Oxygen Demand (UOD), see remark A May June July August September October	 mg/l mg/l mg/l mg/l mg/l mg/l	 50.0 36.2 31.7 31.7 31.7 36.2	 ------ ------ ------ ------ ------ ------	NA	NA	NA	NR	NA	DMR/MOR	
Zinc	mg/l	NA	------	Monthly	Daily Composite	NA	NR	Grab	MOR	*

TABLE A – CONDITIONS

Footnotes:

[1] The permittee shall record and report on the monthly operating report the minimum, maximum and total flow for each day of discharge and the average daily flow for each sampling month. The permittee shall report, on the discharge monitoring report, the average daily flow and maximum daily flow for each sampling month.

[2] The instantaneous limits in this column are maximum limits except for Dissolved Oxygen, which is a minimum limit and pH which is a range of 6 to 9.

[3] During the period beginning at the date of issuance of this permit and lasting until the implementation of Escherichia coli monitoring, the discharge shall not exceed and shall otherwise conform to specific terms and conditions listed for fecal coliform.

[4] During the period beginning after the implementation of Escherichia coli monitoring, which may be before but not later than 730 days after issuance of this permit, the discharge shall also not exceed and shall otherwise conform to the specific terms and conditions listed for Escherichia coli.

[5] For the period beginning April 1st through and including October 31st, in no two consecutive months shall the average monthly effluent concentration exceed 0.7 mg/l.

[6] For the season, beginning April 1st through and including October 31st, the seasonal average shall not exceed 0.7 mg/l. The seasonal average shall be calculated by determining the average monthly discharge of total phosphorus for each month of the season (April through and including October) adding the average monthly discharges together and dividing by 7.

[7] This limit shall be effective beginning **April 1, 2022**.

[8] This limit shall be effective beginning **April 30, 2022** The Average Seasonal Load Cap shall be calculated as follows: The permittee's discharge shall not exceed the total phosphorus Average Seasonal **Load Cap of** 8.95 lb/day **of total phosphorus per day for any two consecutive calendar years or any two of three consecutive calendar years.**

Remarks:

(A) The UOD limit, which is reported monthly, is based on a calculation using average monthly BOD5 and Ammonia Nitrogen results; UOD (mg/l) = (1.5 x BOD_5, average monthly (mg/l)) + (4.6 x NH_3-N, average monthly (mg/l)).

(B) The geometric mean of the Fecal coliform bacteria values for the effluent samples collected in a period of thirty (30) consecutive days during the period from May 1st through September 30th shall not exceed 200 per 100 milliliters.

(C) The geometric mean of the Fecal coliform bacteria values for the effluent samples collected in a period of seven (7) consecutive days during the period from May 1st through September 30th shall not exceed 400 per 100 milliliters.

(D) The geometric mean of the Escherichia coli bacteria values for the effluent samples collected in a period of thirty (30) consecutive days during the period from May 1st through September 30th shall not exceed 126 per 100 milliliters.

(E) UV disinfection shall be operated as designed from May 1st through September 30th.

(F) The Average Weekly discharge Limitation for BOD_5 and Total Suspended Solids shall be 1.5 times the Average Monthly Limit listed above.

(G) The limits for Total Phosphorus (A) in footnotes 5 and 6 are separate and independent requirements; each is enforceable independent of the other.

Figure C-11. Wallingford Water Pollution Control Effluent Limitations.

C.8 Delaware

The Bridgeville Wastewater Treatment Plant, located southwest Delaware in Bridgeville was issued a permit to discharge to the Nanticoke River in the Chesapeake Bay Watershed. The existing permit (DE0020249) expired on January 31, 2012. The permit was issued by the Delaware DNR and Environmental Control. The flow is based on a design flow of 0.8 mgd. The effluent limitations table from the permit is shown in Figure C-12.

The Bridgeville WWTP is one of four significant wastewater facilities that discharge to the Chesapeake Bay and is included in the Chesapeake Bay TMDL and Watershed Implementation Plan for Delaware. The Bridgeville NPDES permit includes TP and TN limits from May through September. The effluent limits are show as mass per day limits that are calculated as the total pounds discharged to the receiving waters in the calendar month, divided by the total calendar days in the month. The permit also includes TP and TN maximum annual discharge load limits.

The current Delaware permits include TN limits between 5.6 to 8 mg/L and TP limits between 1.43 to 2 mg/L TP. The new permits are interesting because they show how the Chesapeake Bay TMDL WLAs are being implemented into NPDES permits in the various states. Proposed nutrient loads are based on current flow limits and the proposed WLA concentrations. As flows increase, the allowable discharge concentration to meet the permitted load will decrease. This will increase the required treatment and costs for the facilities.

Effective Date: February 1, 2009
Expiration Date: January 31, 2012

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B. Effluent Limitations and Monitoring Requirements

1. Outfall 001 – EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning effective date and lasting through the expiration date, the permittee is authorized to discharge from point source 001[1] the quantity and quality of effluent specified below:

Parameter	Effluent Limitations							Monitoring Requirements[2]	
	Load			Concentration				Measurement Frequency	Sample Type
	Daily Average	Daily Maximum	Units	Daily Average	Daily Maximum	Maximum Instantaneous	Units		
Flow[3]			mgd					Continuous	Record/Totalize
Total Residual Chlorine						None Detectable[4]	mg/L	Once per day	Grab
Dissolved Oxygen, Nov. through May						1.0 minimum	mg/L	Once per day	Grab
Dissolved Oxygen, June through Oct.						4.0 minimum	mg/L	Once per day	Grab
pH	The pH shall be between 6.0 S.U. and 9.0 S.U. at all times						S.U.	Once per day	Grab
BOD_5	79.4		lbs/day	20.0	30.0		mg/L	Once per week	Composite
Total Suspended Solids	100.0	150.0	lbs/day	15.0	23.0		mg/L	Once per week	Composite
Enterococcus				100.0[5]			col/100mL	Once per week	Grab
Total Kjeldahl Nitrogen (as N)			lbs/day				mg/L	Once per month	Composite
Ammonia Nitrogen (as N)			lbs/day				mg/L	Once per month	Composite
Total Phosphorus (as P), May 1 through Sept. 30	13.4[6]		lbs/day				mg/L	Once per month	Composite
Total Phosphorus (as P), Oct. 1 through April 30			lbs/day				mg/L	Once per month	Composite
Total Nitrogen (as N), May 1 through Sept. 30	52.9[6]		lbs/day				mg/L	Once per month	Composite
Total Nitrogen (as N), Oct. 1 through April 30			lbs/day				mg/L	Once per month	Composite
Total Nitrogen[7] (as N)	The twelve month cumulative discharge load shall not exceed 19,312 lbs.							Once per month	Composite
Total Phosphorus (as P)	The twelve month cumulative discharge load shall not exceed 4,909 lbs.							Once per month	Composite
Biomonitoring	See Special Condition No. 6.							One time[8]	Composite
The discharge shall be free from floating solids, sludge deposits, debris, oil and scum.									

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location: at the Parshall flume for Outfall 001.

The hydraulic design discharge rate of 0.8 million gallons per day was used in determining the interim effluent limitations for this outfall.

1 See Discharge Description on page 2 of 20 pages of this permit.
2 Report “non-detected” testing results on the discharge monitoring report (DMR) as “<” and the applicable test MDL. For example, if BOD5 is “nondetected” using a test method with an MDL of 2.4 mg/L, report “< 2.4 mg/L” on the DMR.
3 Report both average daily and maximum daily flows on the discharge monitoring report (DMR).
4 See Part III.A, Special Condition No. 6.
5 Compliance with the average enterococcus limit is based on a geometric mean.
6 DMR reported values and compliance with this limit shall be calculated as the total pounds discharged to the receiving waters in the calendar month, divided by the total calendar days in the month.
7 Report both 12-month moving cumulative load and daily average load on DMR. Also report both 12-month moving average and daily average concentration on the DMR.
8 The permittee shall conduct biomonitoring tests in accordance with Special Conditions No. 7 of this permit.

Figure C-13. Bridgeville Wastewater Treatment Plant Effluent Limitations and Monitoring Requirements.

C.9 Florida

The County Regional Wastewater Treatment Plant is located in Hillsborough County, Florida, near Tampa, was issued a permit to discharge to Hillsborough Bay through the Port Redwing Canal. The permit FL0028061 expired on January 14, 2014. The permit was issued by the Florida Department of Environmental Protection. The flow is based on a design flow of 10 mgd, however, only an annual average of 4.5 mgd may be discharged to the Bay. The remaining flow is source water for the South-Central Hillsborough County Master Reuse System. The NPDES permit includes effluent limits for TN and TP. The permit includes nitrogen and phosphorus concentration limits with annual average, monthly average, and single sample averaging periods.

C.10 Georgia

The Oquina Creek Water Pollution Control Plant, located in the southwest Georgia town of Thomasville, was issued a permit to discharge to Oquina Creek, a tributary to the Ochiockonee River. The permit GA0024082 expires on March 22, 2017. The permit was issued by the State of Georgia DNR Environmental Protection Division. The flow is based on a monthly average permitted flow of 6.5 mgd and a weekly average permitted flow of 8.1 mgd. The effluent limitations table from the permit is shown in Figure C-13.

The Oquina Creek WPCP NPDES permit includes effluent limits for ammonia. The ammonia limits are monthly and weekly average concentration and load limits ranging from 2.0 mg/L June through September to 10 mg/L January through March (monthly average). This permit is interesting because it includes a range of effluent ammonia limits depending on the season.

B. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

The discharge from the water pollution control plant shall be limited and monitored by the permittee as follows:

Parameter	Discharge Limitations mg/L (kg/day) unless otherwise specified		Monitoring Requirements		
	Monthly Avg.	Weekly Avg.	Measurement Frequency	Sample Type	Sample Location
Flow – MGD	6.5	8.1	Seven Days/Week	Continuous Recording	Effluent
Biochemical Oxygen Demand (5-day)			Five Days/Week	Composite	Influent And Effluent
January-February	30 (739)	45 (921)			
March, April, & December	20 (493)	30 (614)			
May & November	15 (370)	22.5 (461)			
June-October	10 (246)	15 (307)			
Total Suspended Solids (TSS)	30 (739)	45 (921)	Five Days/Week	Composite	Influent & Effluent
Ammonia (as N)			Five Days/Week	Composite	Effluent
January-March	10 (246)	15 (307)			
April & December	5.0 (123)	7.5 (154)			
May & October	3.0 (74)	4.5 (92)			
June-September	2.0 (49)	3.0 (61)			
November	4.0 (99)	6.0 (123)			

Figure C-13. Oquina Creek Water Pollution Control Plant Effluent Limitations and Monitoring Requirements.

C.11 Hawaii

The NAVFAC Hawaii Wastewater Treatment Plant located at the United States Department of the Navy Joint Base Pearl Harbor-Hickam on the Island of Oahu, Hawaii, was issued a permit to discharge to Mamala Bay, a deep ocean discharge. The permit HI 0110086 expires on September 6, 2016. The permit was issued by the State of Hawaii Department of Health. The flow is based on a design flow of 13 mgd. The effluent limitations table from the permit is shown in Figure C-14.

The NPDES permit includes effluent limits for TN, ammonia, and phosphorus. The limits are written as the geometric mean from the previous 11 months. There are not a maximum number of samples that must be analyzed but all samples that are taken must be analyzed and reported. The TN, ammonia, and TP limits are 16.65 mg/L, 0.39 mg/L, and 2.22 mg/L, respectively.

This permit is interesting because it is one of only a few Hawaii NPDES permits with nutrient limits. Additionally, there are no monthly or weekly average effluent limitations for the nutrients. The facilities must meet an annual geometric mean based on one or more samples per month.

PARAMETER	DISCHARGE LIMITATIONS		UNIT	MINIMUM MONITORING FREQUENCY	SAMPLE TYPE
Settleable Solids	30-day Average	1	ml/l	Once/Day	Grab
	Daily Maximum	2	ml/l		
Oil and Grease	Daily Maximum	10	mg/l	Once/Day	Grab[2]
Enterococcus Bacteria	Geometric Mean[3]	35	CFU/100 ml	Five/Month[4]	Grab
Total Residual Chlorine	Daily Maximum	0.83	mg/l	Variable[5]	Grab/ Recorder[5]
Chronic Whole Effluent Toxicity[6]	Daily Maximum	111	TU_c	Once/Month[8]	24-Hour Composite
Total Nitrogen	Geometric Mean[7]	16.65	mg/l	Once/Month[8]	24-Hour Composite
Nitrate + Nitrite Nitrogen	Geometric Mean[7]	Report	mg/l	Once/Month[8]	24-Hour Composite
Ammonia Nitrogen	Geometric Mean[7]	0.39	mg/l	Once/Month[8]	24-Hour Composite
Total Phosphorous	Geometric Mean[7]	2.22	mg/l	Once/Month[8]	24-Hour Composite

Figure C-14. NAVFAC Hawaii Wastewater Treatment Plant Effluent Limitations.

C.12 Idaho

The Coeur d'Alene Wastewater Treatment Plant, located in the northern Idaho town of Coeur d'Alene, was issued a permit to discharge to the Spokane River. The preliminary draft permit, ID0022853, is expected to be issued in 2012 or early 2013. The permit will be issued by the US EPA, Region 10. The flow is based on a design flow of 7.6 mgd for the parameters in the Spokane River TMDL. The effluent limitations table from the permit is shown in Figure C-15.

The Coeur d'Alene preliminary draft NPDES permit includes lower effluent limitations for ammonia and phosphorus than the existing permit. The ammonia and phosphorus limits are based on the WLAs in the Spokane River DO TMDL and supplemental water quality modeling that was completed to illustrate equivalent loading scenarios. The ammonia limits are seasonal load effluent limits from March to October based on an effluent concentration of 4.29 mg/L and 7.6 mgd. The phosphorus limits are seasonal load effluent limits from February to October based on an effluent concentration of 0.5 mg/L and 7.6 mgd. Additional ammonia limits are in place to protect against effluent toxicity.

With low effluent phosphorus and ammonia limits, the permit structure was critical for Coeur d'Alene. Including a seasonal average limit, as opposed to monthly or weekly average limits, provides the same water quality protection while allowing flexible operations and reduces the impact of a single excursion.

Table 1: Final Effluent Limits and Monitoring Requirements for Outfall 001

Parameter	Units	Effluent limits			Monitoring Requirements		
		Average Monthly Limit	Average Weekly Limit	Max. Daily Limit	Location	Frequency	Sample Type
Total Residual Chlorine July – September	µg/L	39	—	102	Effluent	3/day	Grab
	lb/day	2.0	—	5.1			Calculation[2]
Total Ammonia as N[1] March – June	mg/L	Report	—	Report	Effluent	3/week	24-Hr. Comp.
	lb/day	649	—	1547			Calculation[2]
Total Ammonia as N[1] July – September	mg/L	6.59	—	15.7	Effluent	3/week	24-Hr. Comp.
	lb/day	330	—	786			Calculation[2]
Total Ammonia as N October	mg/L	Report	—	Report	Effluent	3/week	24-Hr. Comp.
	lb/day	525	—	1252			Calculation[2]
Total Ammonia as N[1] March – October	lb/day	Seasonal Average Limit: 272 lb/day. See I.B.11.			Effluent	3/week	24-Hr. Comp.
Total Ammonia as N[1] November – February	mg/L	Report	—	Report	Effluent	1/month	24-Hr. Comp.
Total Phosphorus as P[1] February – October	µg/L	Report	Report	—	Effluent	3/week	24-Hr. Comp.
	lb/day	Report	Report	—			Calculation[2]
	lb/day	Seasonal Average Limit: 3.17 lb/day. See I.B.11.					
Total Phosphorus as P November – January	µg/L	Report	Report	—	Effluent	1/week	24-Hr. Comp.

Figure C-15. Coeur d'Alene Wastewater Treatment Plant Final Effluent Limits and Monitoring Requirements for Outfall 001.

C.13 Illinois

The Metropolitan Water Reclamation District of Chicago Stickney Water Reclamation Plant located in the Cicero, Illinois, was issued a permit to discharge to Chicago Sanitary and Ship Canal. The draft permit IL0028053 was issued in 2009. The permit was issued by the Illinois EPA Division of Water Pollution Control. The flow is based on a design average flow of 1,200 mgd and a design maximum flow of 1,440 mgd. The effluent limitations table from the permit is shown in Figure C-16.

The Stickney WWTP NPDES permit includes effluent limits for ammonia. Monthly average and weekly average concentration and load limits are included. The load calculations are based on both the average and maximum plant flow. The effluent ammonia concentrations range from 2.5 mg/L to 8.0 mg/L. There are two ammonia seasons, April through October and November through March.

The Stickney WWTP is one of the largest treatment plants in the country. It is a very large plant with low effluent ammonia limits that require nitrification in a cold-weather climate.

The effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day* DAF (DMF)			CONCENTRATION LIMITS mg/L			
Parameter	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Regulation
$CBOD_5$	100,080 (120,096)	150,120 (180,144)		10	15		35 IAC 304.120 40 CFR 133.102
Suspended Solids	120,096 (144,115)	200,160 (240,192)		12	20		35 IAC 304.120 40 CFR 133.102
Dissolved Oxygen	Shall be a Daily Minimum of 6 mg/L						35 IAC 302.206
pH	Shall be in the range of 6 to 9 Standard Units						35 IAC 304.125
Ammonia Nitrogen: April-Oct.	25,020 (30,024)		50,040 (60,048)	2.5		5.0	35 IAC 355 and 35 IAC 302
Nov.-March	40,032 (48,038)		80,064 (96,077)	4.0		8.0	
Hardness						Report	35 IAC 302
Cadmium						Report	35 IAC 302
Total Nitrogen					Report		35 IAC 309.146
Total Phosphorus					Report		35 IAC 309.146

*Load Limits are calculated by using the formula: 8.34 x (Design Average and/or Maximum Flow in MGD) x (Applicable Concentration in mg/L).

Figure C-16. Stickney Water Reclamation Plant Effluent Limitations.

Village of Algonquin Wastewater Treatment Plant, located west of Chicago in the Village of Algonquin, Illinois, was issued a permit to discharge to Fox River. The draft permit IL0023329 was issued in 2012. The permit was issued by the Illinois EPA Division of Water Pollution Control. The flow is based on a design average flow of 5 mgd and a design maximum flow of 11.3 mgd. The effluent limitations table from the permit is shown in Figure C-17.

The Village of Algonquin NPDES permit includes effluent limits for ammonia and phosphorus. Monthly average and weekly average concentration and load limits are included for ammonia. Monthly average concentration and load limits are included for phosphorus. The load calculations are based on both the average and maximum plant flow. The effluent ammonia concentrations range from 1.2 mg/L to 3.5 mg/L. There are four ammonia seasons, April/May/September/October, June through August, November through February, and March.

This permit is interesting because it is newer than the Stickney plant. The permit includes more stringent ammonia limits and effluent limits for phosphorus. The permit structure is similar between the two dischargers, however the Algonquin permit has more than two ammonia seasons.

From the effective date of the permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)*			CONCENTRATION LIMITS mg/L			
Parameter	Annual Average	Monthly Average	Weekly Average	Annual Average	Monthly Average	Weekly Average	Regulation
$CBOD_5$	417(942)	834(1885)	1668(3770)	10	20	40	35 IAC 304.120 40 CFR 133.102
Suspended Solids	500(1131)	1043(2356)	1877(4241)	12	25	45	35 IAC 304.120 40 CFR 133.102
pH	Shall be in the range of 6 to 9 Standard Units						35 IAC 304.125
Fecal Coliform**	The monthly geometric means shall not exceed 200 per 100 mL						35 IAC 304.121
Parameter	Monthly Average		Daily Maximum	Monthly Average		Daily Maximum	Regulation
Ammonia Nitrogen: April-May/Sept. - Oct.	63 (141)		67(151)	1.5		1.6	35 IAC 355 and 35 IAC 302
June – August	50 (113)		67 (151)	1.2		1.6	
Nov.- February	-		146 (330)	-		3.5	
March	63(141)		75 (170)	1.5		1.8	
Phosphorus (as P)	42 (94)			1.0			35 IAC 304.123
Total Nitrogen	Monitor Only						35 IAC 309.146
				Monthly Avg. not less than	Weekly Avg. not less than	Daily Minimum	
Dissolved Oxygen March-July				N.A.	6.0	5.0	35 IAC 302.206
August-February				5.5	4.0	3.5	

Figure C-17. Village of Algonquin Wastewater Treatment Plant Effluent Limitations.

C.14 Indiana

Westfield Westside Wastewater Treatment Plant, located north of Indianapolis in Westfield, Indiana, was issued a permit to discharge to Little Eagle Creek. The permit IN0059544 expires on May 31, 2017. The permit was issued by the State of Indiana Department of Environmental Management (DEM). The flow is based on a design flow of 3.0 mgd. The effluent limitations table from the permit is shown in Figure C-18.

The NPDES permit includes effluent limits for ammonia and phosphorus. Limits for ammonia concentration and load are included with different limits in the summer and winter. The effluent phosphorus limits is 1 mg/L TP on a monthly average based on the Indiana State Administrative Code for dischargers within 40 miles upstream of a lake or reservoir within the Great Lakes basin. According to DEM staff, these are the most stringent limits that the state is currently applying in permits.

TABLE 1

Parameter	Quantity or Loading: Monthly Average	Weekly Average	Units	Quality or Concentration: Monthly Average	Weekly Average	Units	Monitoring Requirements: Measurement Frequency	Sample Type
Flow [1]	Report	----	MGD	----	----	----	5 X Weekly	24-Hr. Total
$CBOD_5$								
Summer [2]	376	576	lbs/day	15	23	mg/l	5 X Weekly	24-Hr. Composite
Winter [3]	626	1,001	lbs/day	25	40	mg/l	5 X Weekly	24-Hr. Composite
TSS								
Summer [2]	451	676	lbs/day	18	27	mg/l	5 X Weekly	24-Hr. Composite
Winter [3]	751	1,127	lbs/day	30	45	mg/l	5 X Weekly	24-Hr. Composite
Ammonia-nitrogen								
Summer [2]	32.5	50.1	lbs/day	1.3	2.0	mg/l	5 X Weekly	24-Hr. Composite
Winter [3]	47.6	72.6	lbs/day	1.9	2.9	mg/l	5 X Weekly	24-Hr. Composite
Phosphorus [4]	----	----	----	1.0	----	mg/l	5 X Weekly	24-Hr. Composite

Figure C-18. Westfield Westside Wastewater Treatment Plant Effluent Limitations.

C.15 Iowa

The Waterloo Sewage Treatment Plant, located in the northeast Iowa City of Waterloo, was issued a permit to discharge to an unnamed creek that discharges to the Cedar River. The permit IA0790001 expired on February 28, 2015. The permit was issued by the Iowa DNR. The flow is based on a design average dry weather flow of 18.0 mgd. The effluent limitations table from the permit is shown in Figure C-19.

The permit includes effluent limits for both ammonia and TN. There are different monthly average effluent ammonia concentration and load limits. The ammonia limits are both monthly average and daily maximum. The TN limits are monthly average and daily maximum load values.

Interim Limits Start: 03/01/2010 Interim Limits End: 05/31/2013

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

Wastewater Parameter	Season	Type of Limit	% Removal	EFFLUENT LIMITATIONS							
				Concentration				Mass			
				7 Day Average/Min	30 Day Average	Daily Maximum	Units	7 Day Average	30 Day Average	Daily Maximum	Units
CBOD5	YEARLY	INTER	85	40.0	25.0		MG/L	11,609.0	7,256.0		LBS/DAY
CBOD5	YEARLY	FINAL	85	40.0	25.0		MG/L	11,609.0	7,256.0		LBS/DAY
TOTAL SUSPENDED SOLIDS	YEARLY	INTER	85	45.0	30.0		MG/L	13,060.0	8,707.0		LBS/DAY
TOTAL SUSPENDED SOLIDS	YEARLY	FINAL	85	45.0	30.0		MG/L	13,060.0	8,707.0		LBS/DAY
AMMONIA NITROGEN (N)	JAN	INTER			61.8	128.2	MG/L				
AMMONIA NITROGEN (N)	JAN	FINAL			61.8	128.2	MG/L				
AMMONIA NITROGEN (N)	FEB	INTER			70.3	149.4	MG/L				
AMMONIA NITROGEN (N)	FEB	FINAL			70.3	149.4	MG/L				
AMMONIA NITROGEN (N)	MAR	INTER			30.7	108.5	MG/L		4,998.7		LBS/DAY
AMMONIA NITROGEN (N)	MAR	FINAL			30.7	108.5	MG/L		4,998.7		LBS/DAY
AMMONIA NITROGEN (N)	APR	INTER			21.5	79.8	MG/L		3,519.0		LBS/DAY
AMMONIA NITROGEN (N)	APR	FINAL			21.5	79.8	MG/L		3,519.0	14,363.0	LBS/DAY
AMMONIA NITROGEN (N)	MAY	INTER			18.0	79.1	MG/L		2,962.7		LBS/DAY
AMMONIA NITROGEN (N)	MAY	FINAL			18.0	79.1	MG/L		2,962.7	14,162.8	LBS/DAY
AMMONIA NITROGEN (N)	JUN	INTER			11.6	78.1	MG/L		1,931.6		LBS/DAY
AMMONIA NITROGEN (N)	JUN	FINAL			11.6	78.1	MG/L		1,931.6	13,877.8	LBS/DAY
AMMONIA NITROGEN (N)	JUL	INTER			14.2	87.4	MG/L		2,283.2		LBS/DAY
AMMONIA NITROGEN (N)	JUL	FINAL			14.2	87.4	MG/L		2,283.2		LBS/DAY
AMMONIA NITROGEN (N)	AUG	INTER			13.0	74.1	MG/L		2,082.2		LBS/DAY

Note: If seasonal limits apply, summer is from March 15 through November 15, and winter is from November 16 through March 14.

Figure C-19. Waterloo Sewage Treatment Plant Effluent Limitations.

Outfall No.: 801 TOTAL TREATMENT FACILITY DIFFUSER DISCHARGE.

Interim Limits Start: 03/01/2010 Interim Limits End: 05/31/2013

You are prohibited from discharging pollutants except in compliance with the following effluent limitations:

Wastewater Parameter	Season	Type of Limit	% Removal	EFFLUENT LIMITATIONS							
				Concentration				Mass			
				7 Day Average/Min	30 Day Average	Daily Maximum	Units	7 Day Average	30 Day Average	Daily Maximum	Units
AMMONIA NITROGEN (N)	AUG	FINAL			13.0	74.1	MG/L		2,082.2	13,652.6	LBS/DAY
AMMONIA NITROGEN (N)	SEP	INTER			13.4	94.6	MG/L		2,221.8		LBS/DAY
AMMONIA NITROGEN (N)	SEP	FINAL			13.4	94.6	MG/L		2,221.8		LBS/DAY
AMMONIA NITROGEN (N)	OCT	INTER			30.8	93.5	MG/L		5,020.2		LBS/DAY
AMMONIA NITROGEN (N)	OCT	FINAL			30.8	93.5	MG/L		5,020.2		LBS/DAY
AMMONIA NITROGEN (N)	NOV	INTER			38.7	78.4	MG/L				
AMMONIA NITROGEN (N)	NOV	FINAL			38.7	78.4	MG/L		6,282.3	13,970.8	LBS/DAY
AMMONIA NITROGEN (N)	DEC	INTER			45.8	93.8	MG/L				
AMMONIA NITROGEN (N)	DEC	FINAL			45.8	93.8	MG/L		7,436.3		LBS/DAY
PH (MINIMUM - MAXIMUM)	YEARLY	INTER		6.0		9.0	STD UNITS				
PH (MINIMUM - MAXIMUM)	YEARLY	FINAL		6.0		9.0	STD UNITS				
NITROGEN, TOTAL (AS N)	YEARLY	INTER							9,285.5	15,199.0	LBS/DAY
NITROGEN, TOTAL (AS N)	YEARLY	FINAL							9,285.5	15,199.0	LBS/DAY
ACUTE TOXICITY, CERIODAPHNIA	YEARLY	INTER							1.0		NO TOXICITY
ACUTE TOXICITY, CERIODAPHNIA	YEARLY	FINAL							1.0		NO TOXICITY
ACUTE TOXICITY, PIMEPHALES	YEARLY	INTER							1.0		NO TOXICITY
ACUTE TOXICITY, PIMEPHALES	YEARLY	FINAL							1.0		NO TOXICITY
E. COLI	SUMMER	FINAL			126.0		#/100 ML				

Figure C-20. Waterloo Sewage Treatment Plant Total Treatment Facility Diffuser Discharge for Outfall 801.

C.16 Kansas

A recent example NPDES permit for Kansas has not been identified. The Hays WWTF, located in central Kansas, was issued a permit to discharge to Big Creek via Cheolah Creek. The permit KS0036684 expired on February 28, 2009. The permit was issued by the Kansas Department of Health and Environment. The flow was based on a design average flow of 2.8 mgd. The effluent limitations table from the permit is shown in Figure C-21 and continues in Figure C-22.

The permit includes effluent limits for ammonia. There are different monthly average effluent ammonia concentration limits for each month, ranging from 4.1 mg/L to 11.8 mg/L.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

The permittee is authorized to discharge from outfall(s) with serial number(s) as specified in this permit. The effluent limitations shall become effective on the dates specified herein. Such discharges shall be controlled, limited, and monitored by the permittee as specified. There shall be no discharge of floating solids or visible foam in other than trace amounts.

Monitoring reports shall be submitted on or before the 28th day of the following month. In the event no discharge occurs, written notification is still required.

Effective Date Outfall Number and Effluent Parameters(s)	EFFLUENT LIMITATIONS Final Limitations** Upon Issuance	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Outfall 001 - Discharge to Chetolah Creek			
Biochemical Oxygen Demand (5-Day) - mg/l ***		*Twice Monthly	24 Hour Composite
November through March			
Weekly Average	40		
Monthly Average	25		
April through October			
Weekly Average	30		
Monthly Average	20		
Total Suspended Solids - mg/l		*Twice Monthly	24 Hour Composite
Weekly Average	45		
Monthly Average	30		
pH - Standard Units	6.0-9.0	Twice Monthly	Grab
Ammonia (as N) - mg/l		Twice Monthly	Grab
January			
Monthly Average	11.8		
February			
Monthly Average	11.8		
March			
Monthly Average	7.2		
April			
Monthly Average	7.2		
May			
Monthly Average	5.6		
June			
Monthly Average	4.5		
July			
Monthly Average	4.0		

Figure C-21. Hays Wastewater Treatment Facility Effluent Limitations and Monitoring Requirements.

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Kansas Permit No.: M-SH16-OO02

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (continued)

August
Monthly Average 4.1

September
Monthly Average 6.4

October
Monthly Average 7.5

November
Monthly Average 11.8

December
Monthly Average 11.8

Figure C-22. Hays Wastewater Treatment Facility Effluent Limitations and Monitoring Requirements.

C.17 Kentucky

Symsonia Sewer District located in western Kentucky was issued a permit to discharge to Bear Creek. The permit KY0055271 expires on September 30, 2017. The permit was issued by the Kentucky Department for Environmental Protection. The flow is based on a design flow of 0.10 mgd. The effluent limitations table from the permit is shown in Figure C-23.

The permit includes monthly average and weekly average concentration limits for TP. "The limits for phosphorus are consistent with the requirements of 401 KAR 5:080, Section 1(2)(c) 2. These limits are representative of the Division of Water's BPJ determination of the "Best Practicable Technology Currently Available" (BPT) and "Best Available Technology Economically Achievable" (BAT) requirements for these pollutants."

1.2. Effluent Limitations and Monitoring Requirements

Beginning on the effective date and lasting through the term of this permit discharges from Outfall 001 shall comply with the effluent limitations.

Effluent Characteristic	EFFLUENT LIMITATIONS						MONITORING REQUIREMENTS		
	Loadings (lbs/day)		Concentrations (specify units)				Monitoring		Sample Type
	Monthly Average	Weekly Average	Minimum	Monthly Average	Weekly Average	Maximum	Location	Frequency	
Flow (Design 0.10 MGD)	Report	Report	N/A	N/A	N/A	N/A	Effluent	Continuous	Recorder
Flow (MGD)	Report	Report	N/A	N/A	N/A	N/A	Influent	Continuous	Recorder
$CBOD_5$	8.3	12.5	N/A	10 mg/l	15 mg/l	N/A	Effluent	1/Week	24-Hr Composite
$CBOD_5$	Report	Report	N/A	Report (mg/l)	Report (mg/l)	N/A	Influent	1/Week	24-Hr Composite
Percent Removal $CBOD_5$	N/A	N/A	85 %	N/A	N/A	N/A	N/A	1/Month	Calculated
TSS	25.0	37.4	N/A	30 mg/l	45 mg/l	N/A	Effluent	1/Week	24-Hr Composite
TSS	Report	Report	N/A	Report (mg/l)	Report (mg/l)	N/A	Influent	1/Week	24-Hr Composite
Percent Removal TSS	N/A	N/A	85 %	N/A	N/A	N/A	N/A	1/Month	Calculated
Ammonia (as NH_3N) May 1 – October 31	3.3	5.0	N/A	4 mg/l	6 mg/l	N/A	Effluent	1/Week	24-Hr Composite
Ammonia (as NH_3N) November 1 – April 30	8.3	12.5	N/A	10 mg/l	15 mg/l	N/A	Effluent	1/Week	24-Hr Composite
E. Coli (colonies/100 ml)	N/A	N/A	N/A	130	240	N/A	Effluent	1/Week	Grab
Dissolved Oxygen	N/A	N/A	7.0 mg/l	N/A	N/A	N/A	Effluent	1/Week	Grab
pH (Standard Units)	N/A	N/A	6.0	N/A	N/A	9.0	Effluent	1/Week	Grab
Total Residual Chlorine	N/A	N/A	N/A	0.011 mg/l	0.019 mg/l	N/A	Effluent	1/Week	Grab
Total Phosphorus	N/A	N/A	N/A	1.0 mg/l	2.0 mg/l	N/A	Effluent	1/Week	24-Hr Composite

Figure C-23. Symsonia Sewer District Effluent Limitations and Monitoring Requirements.

C.18 Louisiana

An example NPDES permit has not been identified for Louisiana.

C.19 Maine

An example NPDES permit has not been identified for Maine.

C.20 Maryland

The Broadwater WRF located east of Washington, DC, in Churchton, Maryland, was issued a permit to discharge to the Chesapeake Bay. The permit MD0024350 expired on February 28, 2015. The permit was issued by the Maryland Department of the Environment. The flow is based on a design flow of 2.0 mgd. The effluent limitations table from the permit is shown in Figure C-24.

The permit includes monthly average and weekly average mass and concentration limits annually for TP. These remain in effect until December 31, 2013. There are also annual maximum loading rates for TN and TP that become effective January 1, 2014. These are based on TN concentration of 4.0 mg/L and TP concentration of 0.3 mg/L.

A. Effluent Limitations, Outfall 001 (1) (2) (10)

The quality of the effluent discharged by the facility through a submerged outfall at a discharge point location- 001 shall be limited at all times as shown below:

Effluent Characteristics	Maximum Effluent Limits: Monthly Average Loading Rate, Pounds/day	Weekly Average Loading Rate, Pounds/day	Monthly Average Concentration, mg/l	Weekly Average Concentration, mg/l
BOD_5	501	751	30	45
TSS	501	751	30	45
Total Phosphorus-P (3)	33	50	2.0	3.0

Effluent Characteristics	Maximum Effluent Limits: Total Monthly Loading Rate (6), Pounds/Month	Annual Maximum Loading Rate (7), Pounds/Year	Monthly Average Concentration, mg/l
Total Phosphorus-P (4)(5)(6)(7)(8)	REPORT	1,827	REPORT
Total Nitrogen-N (4)(5)(6)(7)(8)	REPORT	24,364	REPORT

Effluent Characteristics	Effluent Limits: Maximum	Minimum
Fecal Coliform (9)	14 MPN/100 ml monthly median value	N/A
Total Residual Chlorine (11)	nondetectable	N/A
pH	8.5	6.5
Dissolved Oxygen	N/A	5.0 mg/l at anytime

Figure C-24. Broadwater Water Reclamation Facility Effluent Limitations for Outfall 001.

C.21 Massachusetts

The Upper Blackstone Water Pollution Abatement District located in south central Massachusetts in Millbury was issued a permit to discharge to the Blackstone River. The permit MA0102369 expires on an unknown date as the permit is still a draft. The permit was issued by the U.S. EPA Region 1. The flow is based on a design flow of 56 mgd.

The draft permit does not include an effluent limitations table.

The permit includes a monthly average concentration limit seasonally from April through October for TP and a monthly average concentration limit seasonally from May through October for TN.

- The Region has determined that a monthly average TP limit no higher than 0.1 mg/l (100 ug/l) is necessary in order to achieve the applicable WQS. This limit will be in effect seasonally, from April 1 to October 31.

EPA has included in the draft permit a TN limit of 5.0 mg/l monthly average from May through October.

C.22 Michigan

The City of Detroit Wastewater Treatment Plant, located in southeast Michigan was issued a permit to discharge to the Detroit River, Rouge River, and Conner Creek (CSOs). The permit MI0022802 expires on April 1, 2017. The permit was issued by the State of Michigan DEQ. The peak wet weather flow secondary capacity is 930 mgd. The effluent limitations table from the permit is shown in Figure C-25.

The permit includes monitoring for TP and ammonia. The final effluent limits for the dry weather secondary treatment outfall include tiered TP limits. The initial monthly concentration was 1.0 mg/L (7,800 lb/day) which tiered down to 0.7 mg/L (5,400 lb/day) after two years. The final two years of the permit require a six month average (April through September) of 0.6 mg/L (4,600 lb/day).

	Maximum Limits for Quantity or Loading				Maximum Limits for Quality or Concentration					
Parameter	**Monthly**	**7-Day**	**Daily**	**Units**	**Monthly**	**7-Day**	**Daily**	**Units**	**Monitoring Frequency**	**Sample Type**
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
(This flow measurement is all secondary flow including recycle and buffer flows)										
Recycled Flow (Screened Final Effluent)	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily SFE Flow
Buffer Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	194,000	310,000	---	lbs/day	25	40	(report)	mg/l	Daily	24-Hr Composite
Total Suspended Solids	233,000	349,000	---	lbs/day	30	45	---	mg/l	Daily	24-Hr Composite
Total Phosphorus (as P)										
Through Dec. 2014	7800	---	---	lbs/day	1.0	---	(report)	mg/l	Daily	24-Hr Composite
Starting Jan. 2015	5400	---	---	lbs/day	0.7	---	(report)	mg/l	Daily	24-Hr Composite
	Six Month Average (April - Sept.)				**Six Month Average (April - Sept.)**					
Total Phosphorus Starting Oct. 2015	4600	---	---	lbs/day	0.6	---	---	mg/l	(see I.A.3.c)	Calculation

Figure C-25. City of Detroit Wastewater Treatment Plant Effluent Limitations.

C.23 Minnesota

The Minneapolis Metropolitan Council Environmental Services' (MCES) Metropolitan WWTP located in southeastern Minnesota in St. Paul was issued a permit to discharge to the Mississippi River. The permit MN0029815 expired on April 30, 2010. The permit was issued by the Minnesota Pollution Control Agency. The flow is based on a design flow of 251 mgd. The effluent limitations table from the permit is shown in Figure C-26.

The permit includes 12 month moving average concentration and 12 month moving total mass limits for TP.

SD 001: Main Facility Discharge

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
BOD, Carbonaceous 05 Day (20 Deg C)	28486	kg/day	Calendar Month Average	Oct-May	24-Hour Flow Composite	5 x Week	27
BOD, Carbonaceous 05 Day (20 Deg C)	24	mg/L	Calendar Month Average	Oct-May	24-Hour Flow Composite	5 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	51257	kg/day	Maximum Calendar Week Average	Oct-May	24-Hour Flow Composite	5 x Week	28
BOD, Carbonaceous 05 Day (20 Deg C)	40	mg/L	Maximum Calendar Week Average	Oct-May	24-Hour Flow Composite	5 x Week	
BOD, Carbonaceous 05 Day (20 Deg C) Percent Removal	85	%	Minimum Calendar Month Average	Jan-Dec	Calculation	5 x Week	
Cadmium, Total (as Cd)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	6
Chlorine, Total Residual	0.038	mg/L	Daily Maximum	Apr-Oct	Grab	1 x Day	19
Chromium, Total (as Cr)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	7
Copper, Total (as Cu)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	8
Cyanide, Free (Amen To Chlorination)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	Grab	1 x Week	13
Cyanide, Total (as CN)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	Grab	1 x Week	14
Fecal Coliform, MPN or Membrane Filter 44.5C	200	#100ml	Calendar Month Geometric Mean	Apr-Oct	Grab	5 x Week	
Lead, Total (as Pb)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	9
Mercury, Total (as Hg)	0.0085	kg/day	Calendar Month Average	Jan-Dec	Grab	2 x Month	3
Mercury, Total (as Hg)	9	ng/L	Calendar Month Average	Jan-Dec	Grab	2 x Month	31
Mercury, Total (as Hg)	14	ng/L	Daily Maximum	Jan-Dec	Grab	2 x Month	31
Nickel, Total (as Ni)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	11
Nitrogen, Ammonia, Total (as N)	Monitor Only	kg/day	Calendar Month Average	Dec-Apr	24-Hour Flow Composite	5 x Week	
Nitrogen, Ammonia, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Dec-Apr	24-Hour Flow Composite	5 x Week	
Nitrogen, Ammonia, Total (as N)	Monitor Only	kg/day	Maximum Calendar Week Average	Dec-Apr	24-Hour Flow Composite	5 x Week	
Nitrogen, Ammonia, Total (as N)	Monitor Only	mg/L	Maximum Calendar Week Average	Dec-Apr	24-Hour Flow Composite	5 x Week	
Nitrogen, Nitrate, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Week	
Nitrogen, Nitrite, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Week	
PCBs (Polychlorinated biphenyls)	0.039	gr/day	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	15
PCBs (Polychlorinated biphenyls)	0.041	ng/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	2
PCBs (Polychlorinated biphenyls)	0.07	ng/L	Daily Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	15
pH	9.0	SU	Calendar Month Maximum	Jan-Dec	Grab	5 x Week	1
pH	6.0	SU	Calendar Month Minimum	Jan-Dec	Grab	5 x Week	1

Figure C-26. MCES Metro Plant Effluent Limitations.

SD 001: Main Facility Discharge

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Phosphorus, Dissolved	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	5 x Week	
Phosphorus, Total (as P)	1.0	mg/L	12 Month Moving Average	Jan-Dec	24-Hour Flow Composite	5 x Week	4
Phosphorus, Total (as P)	431077	kg/yr	12 Month Moving Total	Jan-Dec	24-Hour Flow Composite	5 x Week	26
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	5 x Week	
Phosphorus, Total (as P)	Monitor Only	kg/mo	Calendar Month Total	Jan-Dec	24-Hour Flow Composite	5 x Week	5
Solids, Total Suspended (TSS)	35608	kg/day	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	5 x Week	27
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	5 x Week	
Solids, Total Suspended (TSS)	57664	kg/day	Maximum Calendar Week Average	Jan-Dec	24-Hour Flow Composite	5 x Week	28
Solids, Total Suspended (TSS)	45	mg/L	Maximum Calendar Week Average	Jan-Dec	24-Hour Flow Composite	5 x Week	
Solids, Total Suspended (TSS) Percent Removal	85	%	Minimum Calendar Month Average	Jan-Dec	Calculation	5 x Week	
Zinc, Total (as Zn)	Monitor Only	ug/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Month	12

Figure C-26. MCES Metro Plant Effluent Limitations. (continued from previous page)

C.24 Mississippi

The Jackson POTWs located in the west-central Mississippi was issued a permit to discharge to the Pearl River. The permit MS0024295 expires on April 30, 2017. The permit was issued by the Mississippi DEQ. The flow is based on a design flow of 46 mgd. The effluent limitations table from the permit is shown in Table C-1.

The permit includes a monthly average and maximum weekly average mass limits annually for TN and TP.

Table C-1. Jackson Effluent Limitations Outfall 001 (Municipal Wastewater).

Subject Item: **Outfall 001 (Municipal Wastewater)**

RPNT0000000001: MS0024295-001

Such discharges shall be limited and monitored by the permittee as specified below:

Parameter	Discharge Limitations							Monitoring Requirements		
	Quantity / Loading Average	Quantity / Loading Maximum	Quantity / Loading Units	Quality / Conc. Minimum	Quality / Conc. Average	Quality / Conc. Maximum	Quality / Conc. Units	Frequency	Sample Type	Which Months
Ammonia Nitrogen, Total (as N) Effluent	1652 Monthly Average	2503 Maximum Weekly Average	pounds per day	******	3.3 Monthly Average	5.0 Maximum Weekly Average	mg/L	Daily	24-hr Composite	Nov-Apr
Ammonia Nitrogen, Total (as N) Effluent	768 Monthly Average	1152 Maximum Weekly Average	pounds per day	******	2 Monthly Average	3 Maximum Weekly Average	mg/L	Daily	24-hr Composite	May-Oct
Ammonia Nitrogen, Total (as N) Influent	Report Monthly Average	Report Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec
Chlorine, total residual Effluent	******	******	******	******	0.056 Monthly Average	0.096 Maximum Weekly Average	mg/L	Daily	Grab Sampling	Jan-Dec
Fecal coliform, general Effluent	******	******	******	******	200 Monthly Average	400 Maximum Weekly Average	# of colonies/100 ml	Daily	Grab Sampling	Jan-Dec
Flow Effluent	46 Monthly Average	Report Maximum Weekly Average	Million Gallons per Day	******	******	******	******	Continuously	Continuous Recorder	May-Oct
Flow Effluent	60 Monthly Average	Report Maximum Weekly Average	Million Gallons per Day	******	******	******	******	Continuously	Continuous Recorder	Nov-Apr
Nitrogen (Total) Effluent	5221 Monthly Average	7831 Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec

Parameter	Discharge Limitations							Monitoring Requirements		
	Quantity / Loading Average	Quantity / Loading Maximum	Quantity / Loading Units	Quality / Conc. Minimum	Quality / Conc. Average	Quality / Conc. Maximum	Quality / Conc. Units	Frequency	Sample Type	Which Months
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Effluent	10014 Monthly Average	15021 Maximum Weekly Average	pounds per day	******	20 Monthly Average	30 Maximum Weekly Average	mg/L	Daily	24-hr Composite	Nov-Apr
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Effluent	2687 Monthly Average	4031 Maximum Weekly Average	pounds per day	******	7 Monthly Average	10.5 Maximum Weekly Average	mg/L	Daily	24-hr Composite	May-Oct
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Influent	Report Monthly Average	Report Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec
Oxygen Demand, carbonaceous biochemical, 5-day (20 degrees C) Percent Removal	******	******	******	85 Minimum	******	******	%	Monthly	Calculations	Jan-Dec
Oxygen, dissolved Effluent	******	******	******	6.0 Minimum	******	******	mg/L	Daily	Grab Sampling	Jan-Dec
Oxygen, dissolved In Aeration Unit	******	******	******	Report Minimum	******	Report Maximum	mg/L	Daily	Grab Sampling	Jan-Dec
pH Effluent	******	******	******	6.0 Minimum	******	9.0 Maximum	SU	Daily	Grab Sampling	Jan-Dec
Phosphorus (Total) Effluent	1180 Monthly Average	1770 Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec

Parameter	Discharge Limitations							Monitoring Requirements		
	Quantity / Loading Average	Quantity / Loading Maximum	Quantity / Loading Units	Quality / Conc. Minimum	Quality / Conc. Average	Quality / Conc. Maximum	Quality / Conc. Units	Frequency	Sample Type	Which Months
Sludge Settleability 30 Minute In Aeration Unit	******	******	******	Report Minimum	******	Report Maximum	ml/L	Daily	Measurement	Jan-Dec
Solids (Total Suspended) Effluent	11516 Monthly Average	17274 Maximum Weekly Average	pounds per day	******	30 Monthly Average	45 Maximum Weekly Average	mg/L	Daily	24-hr Composite	May-Oct
Solids (Total Suspended) Effluent	15021 Monthly Average	22532 Maximum Weekly Average	pounds per day	******	30 Monthly Average	45 Maximum Weekly Average	mg/L	Daily	24-hr Composite	Nov-Apr
Solids (Total Suspended) Influent	Report Monthly Average	Report Maximum Weekly Average	pounds per day	******	Report Monthly Average	Report Maximum Weekly Average	mg/L	Daily	24-hr Composite	Jan-Dec
Solids (Total Suspended) Percent Removal	******	******	******	85 Minimum	******	******	% removal efficiency	Monthly	Calculations	Jan-Dec
% Effect Static Renewal 7-Day Chronic Ceriodaph nia Effluent	******	******	******	19.71 Minimum	******	******	%	Quarterly	Composite Sample	Jan-Dec
% Effect Static Renewal 7-Day Chronic Pimephale s Effluent	******	******	******	19.71 Minimum	******	******	%	Quarterly	Composite Sample	Jan-Dec

C.25 Missouri

The Springfield Southwest Wastewater Treatment Plant located in southwestern Missouri was issued a permit to discharge to Wilson Creek. The permit MO-0049522 expired on August 8, 2007. The permit was issued by Missouri DNR. The flow is based on a design flow of 42.5 mgd. The effluent limitations table from the permit is shown in Figure C-27. The permit includes a monthly average concentration limit for TP.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS					PAGE NUMBER 3 of 12 PERMIT NUMBER MO-0049522	
The permittee is authorized to discharge from outfall(s) with serial number(s) as specified in the application for this permit. The final effluent limitations shall become effective upon issuance and remain in effect until expiration of the permit. Such discharges shall be controlled, limited and monitored by the permittee as specified below:						
OUTFALL NUMBER AND EFFLUENT PARAMETER(S)	UNITS	FINAL EFFLUENT LIMITATIONS			MONITORING REQUIREMENTS	
		DAILY MAXIMUM	WEEKLY AVERAGE	MONTHLY AVERAGE	MEASUREMENT FREQUENCY	SAMPLE TYPE
Outfall #001						
Flow	MGD	*		*	once/day	24 hr. total
Biochemical Oxygen Demand$_5$**	mg/L		15	10	once/week	24 hr. comp.
Total Suspended Solids**	mg/L		20	15	once/week	24 hr. comp.
pH – Units	SU	***		***	once/week	grab
Fecal Coliform	#/100 ml	1000		400	once/week	grab
Temperature	°C	*		*	once/week	grab
Ammonia as N	mg/L	*	3.0	2.0	once/week	grab
Nitrate & Nitrite as N	mg/L	*		*	once/week	grab
Total Phosphorus as P	mg/L	*		0.5	once/week	grab
MONITORING REPORTS SHALL BE SUBMITTED MONTHLY; THE FIRST REPORT IS DUE FEBRUARY 28, 2005.						
Whole Effluent Toxicity (WET Test)	% Survival		See Special Conditions #1		once/quarter****	24 hr. comp.
MONITORING REPORTS SHALL BE SUBMITTED QUARTERLY; THE FIRST REPORT IS DUE OCTOBER 28, 2004.						
Total Toxic Organics (Note 1)	µg/L	*		*	once/quarter****	grab
Arsenic, Total Recoverable	µg/L	20		20	once/quarter****	24 hr. comp.
Cadmium, Total Recoverable	µg/L	13		13	once/quarter****	24 hr. comp.
Chromium, Total Recoverable	µg/L	42		42	once/quarter****	24 hr. comp.
Copper, Total Recoverable	µg/L	29		29	once/quarter****	24 hr. comp.
Lead, Total Recoverable	µg/L	20		20	once/quarter****	24 hr. comp.
Mercury, Total Recoverable	µg/L	0.5		0.5	once/quarter****	24 hr. comp.
Nickel Total Recoverable	µg/L	500		500	once/quarter****	24 hr. comp.
Silver, Total Recoverable	µg/L	*		*	once/quarter****	24 hr. comp.
Zinc, Total Recoverable	µg/L	345		345	once/quarter****	24 hr. comp.
Cyanide (Amenable to Chlorination)	µg/L	*****		*****	once/quarter****	24 hr. comp.
MONITORING REPORTS SHALL BE SUBMITTED QUARTERLY; THE FIRST REPORT IS DUE APRIL 28, 2005. THERE SHALL BE NO DISCHARGE OF FLOATING SOLIDS OR VISIBLE FOAM IN OTHER THAN TRACE AMOUNTS.						

Figure C-27. Springfield Southwest Wastewater Treatment Plant Effluent Limitations.

C.26 Montana

The City of Kalispell Wastewater Treatment Plant located in northwestern Montana was issued a permit to discharge to Ashley Creek. The permit MT0021938 expired in August 2008. The permit was issued by the Montana DEQ. The flow is based on a design flow of 5.4 mgd. The effluent limitations table from the permit is shown in Figure C-28.

The permit includes average monthly concentration and mass limits annually for TP. Also includes are average monthly and maximum daily mass limits annually for TN. These are interim limits based on existing loading until a TMDL is developed.

Outfall 001

<u>Final Limitations</u>

The following final effluent limitations will be applied to the discharge at Outfall 001 upon the effective date of the permit and remain in effect for the duration of the permit cycle.

Parameter	Units	Average Monthly Limit (1)	Average Weekly Limit (1)	Maximum Daily Limit (1)
BOD_5	mg/L	10	15	--
	lb/day	259	388	--
TSS	mg/L	10	15	--
	lb/day	259	388	--
E. coli Bacteria, winter (2, 3)	cfu/100 mL	630	--	1,260
E. coli Bacteria, summer (2, 3)	cfu/100 mL	126	--	252
Total Phosphorus as P	mg/L	1.0	--	--
	lb/day	25.8	--	--
Total Nitrogen (4)	lb/day	268	--	364
Total Ammonia as N	mg/L	--	--	2.22
Total Ammonia as N, winter (2)	mg/L	2.16	--	--
Total Ammonia as N, summer (2)	mg/L	1.23	--	--
Oil and Grease	mg/L	NA	NA	10
Dissolved Oxygen Saturation	Percent	--	--	>75%

Footnotes: NA means not applicable.
(1) See Definition section at end of permit for explanation of terms.
(2) Winter is November 1 through March 31; summer is April 1 through October 31.
(3) Report geometric mean if more than one sample is collected during the reporting period.
(4) Calculated as the sum of Nitrate + Nitrite as N and Total Kjeldahl Nitrogen concentrations.

Figure C-28. City of Kalispell Final Effluent Limitations for Outfall 001.

C.27 Nebraska

The Hastings Pollution Control Facility, located in south central Nebraska in the town of Hastings, was issued a permit to discharge to the West Fork of the Big Blue River. The permit NE0038946 expired on June 30, 2013. The permit was issued by the Nebraska DEQ. The average facility influent flow is 3.82 mgd. The interim effluent limitations table from the permit is shown in Figure C-29.

The permit includes average monthly and maximum daily load and concentration limits that are applied over several seasons. The limits are applied in the spring (March through May), Summer (June through October) and Winter (November through February) for ammonia. There final limits for ammonia are shown in Figure C-30.

Table 2: Interim Permit Seasonal Discharge Limits and Monitoring Requirements for Ammonia

PARAMETER STORET #	QUANTITY OR LOADING			QUALITY OR CONCENTRATION			FREQUENCY OF ANALAYSIS	SAMPLE TYPE
	VALUE	VALUE	UNITS	VALUE	VALUE	UNITS		
Spring Ammonia (March 1 – May 31) 00610	128.3 MONTHLY AVERAGE	204.9 MAXIMUM DAILY	kg/ day	8.7 MONTHLY AVERAGE	13.9 MAXIMUM DAILY	mg/L	TWICE PER WEEK	24-HOUR COMPOSITE
Summer Ammonia (June 1 – Oct. 31) 00610	131.4 MONTHLY AVERAGE	211.8 MAXIMUM DAILY	kg/ day	8.5 MONTHLY AVERAGE	13.7 MAXIMUM DAILY	mg/L	TWICE PER WEEK	24-HOUR COMPOSITE
Winter Ammonia (Nov. 1 – Feb. 28 [29]) 00610	119.4 MONTHLY AVERAGE	190.2 MAXIMUM DAILY	kg/ day	8.1 MONTHLY AVERAGE	12.9 MAXIMUM DAILY	mg/L	TWICE PER WEEK	24-HOUR COMPOSITE

Abbreviations:
kg/day – kilograms per day mg/L – milligrams per liter

Figure C-29. Hastings Interim Permit Seasonal Discharge Limits and Monitoring Requirements for Ammonia.

Hastings Pollution Control Facility
NPDES Permit Number NE0038946

Page 4 of 18
Effective Date: July 1, 2008
Modification Date: July 1, 2011

Table 3: Final Permit Seasonal Discharge Limits and Monitoring Requirements for Ammonia

PARAMETER STORET #	QUANTITY OR LOADING			QUALITY OR CONCENTRATION			FREQUENCY OF ANALAYSIS	SAMPLE TYPE
	VALUE	VALUE	UNITS	VALUE	VALUE	UNITS		
Spring Ammonia (March 1 – May 31) 00610	26.7 MONTHLY AVERAGE	65.6 MAXIMUM DAILY	kg/ day	1.88 MONTHLY AVERAGE	4.61 MAXIMUM DAILY	mg/L	TWICE PER WEEK	24-HOUR COMPOSITE
Summer Ammonia (June 1 – Oct. 31) 00610	27.9 MONTHLY AVERAGE	68.4 MAXIMUM DAILY	kg/ day	1.88 MONTHLY AVERAGE	4.61 MAXIMUM DAILY	mg/L	TWICE PER WEEK	24-HOUR COMPOSITE
Winter Ammonia (Nov. 1 – Feb. 28 [29]) 00610	35.6 MONTHLY AVERAGE	80.3 MAXIMUM DAILY	kg/ day	2.48 MONTHLY AVERAGE	5.60 MAXIMUM DAILY	mg/L	TWICE PER WEEK	24-HOUR COMPOSITE

Abbreviations:
kg/day – kilograms per day mg/L – milligrams per liter

Figure C-30. Hastings Final Permit Seasonal Discharge Limits and Monitoring Requirements for Ammonia.

C.28 Nevada

The Truckee Meadows WRF located in Sparks, Nevada, was issued a permit to discharge to the Truckee River via Steamboat Creek (Permit NV0020150). The permit was issued by the State of Nevada Division of Environmental Protection. The flow is based on a design flow of 44.0 mgd. The effluent limitations table from the permit is shown in Figure C-31.

The Truckee River TN TMDL includes a TN WLA for the Truckee Meadows WRF of 500 pounds per day. The Truckee River TP TMDL includes a TP WLA for Truckee Meadows WRF of 134 pounds per day. The permit includes TN and TP load limits equal to the WLAs. The permit also includes a daily maximum nitrate limit and a 30-day average phosphorus concentration limit.

Table 3. Discharge Limitations, Sampling and Monitoring Requirements

Parameters	Units	Discharge Limitations			Monitoring Requirements		
		30-Day Average	Daily Max	30-Day Avg Load (ppd)	Sampling Locations	Monitoring Frequency	Monitoring Type
Influent Flow Rate	MGD	44.0	M&R	---	INF (i)	Continuous	Flow meter
Effluent Flow Rate	MGD	M&R	M&R	---	EFF (ii)	Continuous	Flow meter
BOD_5 (uninhibited)	mg/l	M&R	M&R	M&R	INF (i)	3 Times/ Week	Composite
		20	30	7,339 -avg 11,009 - daily max	EFF (ii)		
TSS	mg/l	M&R	M&R	M&R	INF (i)	3 Times/ Week	Composite
		20	30	7,339 -avg 11,009 - daily max	EFF (ii)		
TDS	mg/l	---	500	120,168 [1]	EFF (ii)	Weekly	Composite
TN as N	mg/l	---	---	500 [1]	EFF (ii)	Weekly	Composite
TKN as N	mg/l	M&R	M&R	---	EFF (ii)	Weekly	Composite [9]
Nitrate as N	mg/l	---	2.0	---	EFF (ii)	Daily	Composite
DON as N	mg/l	M&R	M&R	---	EFF (ii)	Weekly	Composite [9]
Total Ammonia as N	mg/l	---	I.A.1.c.2	---	EFF (ii)	Daily	Composite
		---	I.A.1.c.1	---	iii	Weekly [11]	Discrete
TP as P	mg/l	0.40	---	134 [1]	EFF (ii)	Daily	Composite
Alkalinity as $CaCO_3$ [3]	mg/l	M&R	M&R	---	EFF (ii)	Weekly	Composite [9]
Hardness as $CaCO_3$ [3]	mg/l	M&R	M&R	---	iv	Quarterly	Discrete
TRC	mg/l	---	0.10 [2]	---	EFF (ii)	Daily	Discrete
Temperature [4]	°C	M&R			iii, v	Weekly	Discrete
ΔT [4]		< 2.0 [10]					
Fecal Coliform	MPN/ 100ml	200 [5]	400 [6]	---	EFF (ii)	Daily	Discrete
Escherichia Coli	MPN/ 100ml	126 [8]	410	---	EFF (ii)	Daily	Discrete
DO	mg/l	---	≥ 5.0	---	EFF (ii)	Daily	Discrete
pH -SV	S.U.	---	6.5-9.0 [2]	---	EFF (ii)	Daily	Discrete
		M&R			iii	Weekly	
Priority Pollutants -Full Scan	µg/l	---	---	---	INF (i)	Annually (4th qtr)	Composite
Priority Pollutants - Present Pollutants	µg/l	---	[7]	---	EFF (ii)	Quarterly	Composite

Figure C-31. Truckee Meadows Water Reclamation Facility Discharge Limitations, Sampling and Monitoring Requirements.

C.29 New Hampshire

The Concord WWTP located in New Hampshire was issued a permit to discharge to the Merrimack River. The permit NH0100901 expires on September 1, 2016. The permit was issued by the U.S. EPA, Region 1. The flow is based on a design flow of 10.1 mgd. The effluent limitations table from the permit is shown in Figure C-32.

The NPDES permit includes average monthly phosphorus load limits, applicable April through October. The phosphorus limits were set based on EPA's Gold Book approach since it is more effects-based than the ecoregional criteria.

Effluent Characteristic	Discharge Limitations			Monitoring Requirements	
	Average Monthly	Average Weekly	Maximum Daily	Measurement Frequency	Sample Type
Flow; MGD	Report	---	Report	Continuous Recorder[1]	
BOD_5; mg/l (lbs/day)	30 (2529)	45 (3793)	50 (4214)	2/Week[2]	24 Hour Composite
TSS; mg/l (lbs/day)	30 (2529)	45 (3793)	50 (4214)	2/Week[2]	24 Hour Composite
Total Phosphorus; lb/d (mg/l) (Applicable April 1 through October 31)	199 (Report)	---	Report	1/Week	24 Hour Composite
pH Range[3]; Standard Units	6.5 to 8.0 (See I.I.5.)			1/Day	Grab
Total Residual Chlorine[4,6]; mg/l	0.36	---	0.62	1/Day	Grab
Escherichia coli[4,5]; Colonies/100 ml	126	---	406	3/Week	Grab
Total Recoverable Aluminum; ug/l	---	---	Report	2/Month	24 Hour Composite
Whole Effluent Toxicity					
LC50 [7,8,9]; Percent	---	---	100	1/Quarter	24 Hour Composite
Hardness[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite
Ammonia Nitrogen as N[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite
Total Recoverable Aluminum[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite
Total Recoverable Cadmium[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite
Total Recoverable Copper[10] mg/l	---	---	Report	1/Quarter	24 Hour Composite
Total Recoverable Nickel[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite
Total Recoverable Lead[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite
Total Recoverable Zinc[10]; mg/l	---	---	Report	1/Quarter	24 Hour Composite

Figure C-32. Concord Wastewater Treatment Plant Effluent Limitations and Monitoring Requirements.

C.30 New Jersey

Allamuchy Sewerage Treatment Plant, located in the Township of Allamuchy, New Jersey, was issued a permit to discharge to the Pequest River in the Delaware River Basin. The permit NJ0020605 was issued by the New Jersey Department of Environmental Protection. The flow is based on a design flow of 0.6 mgd. The effluent limitations table from the permit is shown in Table C-2.

The NDPES permit includes limits for both phosphorus and ammonia. The phosphorus limits are based on numeric nutrient criteria in the New Jersey WQS. The ammonia limits in the NPDES permit are based on the New Jersey WQS and fish toxicity calculations.

Table C-2. Allamuchy Sewerage Treatment Plant Effluent Limitations.

PARAMETER	UNITS	AVERAGING PERIOD	WASTEWATER DATA (3)	EXISTING LIMITS	INTERIM LIMITS (4)	FINAL LIMITS (4)	MONITORING	
							Freq.	Sample Type
Flow	MGD	Monthly Avg. Daily Max.	0.275 0.851	MR MR	MR MR	MR MR	Continuous	Metered
5 Day Biochemical Oxygen Demand (BOD_5)	kg/d	Monthly Avg. Weekly Avg.	2.3 3.6	34 52	34 52	34 52	3 / Month	6 Hr. Composite
5 Day Biochemical Oxygen Demand (BOD_5)	mg/L	Monthly Avg. Weekly Avg.	2.5 3.6	15 23	15 23	15 23	3 / Month	6 Hr. Composite
Influent BOD_5	mg/L	Monthly Avg. Weekly Avg.	201 240	MR MR	MR MR	MR MR	3 / Month	6 Hr. Composite
BOD_5 Minimum Percent Removal	%	Monthly Avg.	98.8	85	85	85	3 / Month	Calculated
Total Suspended Solids (TSS)	kg/d	Monthly Avg. Weekly Avg.	2.32 3.05	68 102	68 102	68 102	3 / Month	6 Hr. Composite
Total Suspended Solids (TSS)	mg/L	Monthly Avg. Weekly Avg.	2.40 3.21	30 45	30 45	30 45	3 / Month	6 Hr. Composite
Influent Total Suspended Solids (TSS)	mg/L	Monthly Avg. Weekly Avg.	232 290	MR MR	MR MR	MR MR	3 / Month	6 Hr. Composite
TSS Minimum Percent Removal	%	Monthly Avg.	98.9	85	85	85	3 / Month	Calculated
Phosphorus (Total as P) Year Round	kg/d	Monthly Avg. Weekly Avg.	1.11 1.30	0.34 (5) 0.23 (5)	-- --	-- --	-- --	-- --
Phosphorus (Total as P) Year Round	mg/L	Monthly Avg. Weekly Avg.	1.19 1.32	0.1 (5) 0.15 (5)	-- --	-- --	-- --	-- --
Phosphorus (Total as P) Summer (1)	kg/d	Monthly Avg. Weekly Avg.	1.21 1.43	-- --	1.32 MR	1.32 MR	3 / Month	6 Hr. Composite
Phosphorus (Total as P) Summer (1)	mg/L	Monthly Avg. Weekly Avg.	1.32 1.50	-- --	MR MR	MR MR	3 / Month	6 Hr. Composite
Phosphorus (Total as P) Winter (1)	kg/d	Monthly Avg. Weekly Avg.	1.00 1.17	-- --	1.94 MR	1.94 MR	3 / Month	6 Hr. Composite
Phosphorus (Total as P) Winter (1)	mg/L	Monthly Avg. Weekly Avg.	1.05 1.14	-- --	MR MR	MR MR	3 / Month	6 Hr. Composite
Fecal Coliform (geometric mean)	# per 100mL	Monthly Avg. Weekly Avg.	29 67.5	200 400	200 400	200 400	2 / Month	Grab (7)
E. Coli (6) (geometric mean)	# per 100mL	Monthly Avg. Instant Max	-- --	-- --	MR MR	MR MR	5 / Month	Grab (7)

Dissolved Oxygen (minimum)	mg/L	Instant Min. Weekly Avg.	6.3 6.3	MR 6	MR 6	MR 6	3 / Month	Grab
Oil and Grease	mg/L	Monthly Avg. Instant Max.	< 5 < 5	10 15	10 15	10 15	Quarterly	Grab
Influent Temperature	°C	Instant. Min. Monthly Avg. Instant. Max.	7 15.3 23	MR MR MR	MR MR MR	MR MR MR	Daily	Grab
Effluent Temperature	°C	Instant. Min. Monthly Avg. Instant. Max.	6 14.9 24	MR MR MR	MR MR MR	MR MR MR	Daily	Grab
Influent pH	su	Instant. Min. Instant. Max.	7.4 8.5	MR MR	MR MR	MR MR	Daily	Grab
Effluent pH	su	Instant. Min. Instant. Max.	7.3 8.2	6.0 9.0	6.0 9.0	6.0 9.0	Daily	Grab
Ammonia (Total as N), Summer (1)	kg/d	Monthly Avg. Daily Max.	0.22 3.2	4.6 8.6	4.6 8.6	4.6 8.6	3 / Month	6 Hr. Composite
Ammonia (Total as N), Summer (1)	mg/L	Monthly Avg. Daily Max.	0.20 2.43	2 3.8	2 3.8	2 3.8	3 / Month	6 Hr. Composite
Ammonia (Total as N), Winter (1)	kg/d	Monthly Avg. Daily Max.	0.26 3.78	9 17	9 17	9 17	3 / Month	6 Hr. Composite
Ammonia (Total as N), Winter (1)	mg/L	Monthly Avg. Daily Max.	0.24 3.18	4 7.5	4 7.5	4 7.5	3 / Month	6 Hr. Composite
Chlorine Produced Oxidants	kg/d	Month Avg. Daily Max.	< 0.16 < 0.32	0.16 (2) 0.041 (2)	0.16 (2) 0.041 (2)	0.16 (2) 0.041 (2)	Daily	Grab
Chlorine Produced Oxidants	mg/L	Month Avg. Daily Max.	< 0.1 < 0.1	0.007(2) 0.018 (2)	0.007(2) 0.018 (2)	0.007(2) 0.018 (2)	Daily	Grab
Copper, Total Recoverable (8)	g/day	Monthly Avg. Daily Max.	12.6 25.9	MR 43 (Stayed)	-- --	-- --	-- --	-- --
Copper, Total Recoverable (8)	μg/L	Monthly Avg. Daily Max.	12.3 17.7	MR 19 (Stayed)	-- MR	-- MR	Semi- Annual	4 Hr. Composite
Zinc, Total Recoverable (8)	g/day	Monthly Avg. Daily Max.	42.7 68.5	MR 263 (Stayed)	-- --	-- --	-- --	-- --
Zinc, Total Recoverable (8)	μg/L	Monthly Avg. Daily Max.	43.5 62.4	MR 116 (Stayed)	-- MR	-- MR	Semi- Annual	4 Hr. Composite

Chloroform (8)	g/day	Monthly Avg. Daily Max.	3.1 8.1	MR 12.9 (Stayed)	-- --	-- --	-- --	-- --
Chloroform (8)	μg/L	Monthly Avg. Daily Max.	3.3 8.7	MR 5.7 (Stayed)	-- MR	-- MR	Annual	Grab
Dichlorobromomethane (9) (DCBM)	g/day	Monthly Avg. Daily Max.	1.44 4.88	MR MR	MR MR	1.2 2.3	Monthly	Grab
Dichlorobromomethane (9) (DCBM)	μg/L	Monthly Avg. Daily Max.	1.46 4.34	MR MR	MR MR	0.55 1.0	Monthly	Grab
Chronic Toxicity, IC25 State 7day Chr Pimephales	% effluent	Minimum	< 100 (10)	61	61	61	Semi- Annual	Composite

C.31 New Mexico

The City of Ruidoso Downs and Village of Ruidoso WWTP located in Ruidoso, New Mexico, was issued a permit to discharge to the Rio Ruidoso in the Pecos River Basin. The permit NM0029165 expires on July 31, 2017. The permit was issued by the US EPA, Region 6. The flow is based on a design flow of 2.7 mgd. The effluent limitations table from the permit is shown in Figure C-33.

The NPDES permit includes TP and TN limitations. The permit includes monthly average load limits and monthly maximum and daily maximum concentration limits for both phosphorus and ammonia.

This permit is of interest because the nutrients, specifically non-toxic phosphorus, include maximum daily limits.

EFFLUENT CHARACTERISTICS	DISCHARGE LIMITATIONS							
	lbs/day, unless noted			mg/L, unless noted (*1)			MONITORING REQUIREMENTS	
POLLUTANT	30-DAY AVG	DAILY MAX	7-DAY AVG	30-DAY AVG	DAILY MAX	7-DAY AVG	MEASUREMENT FREQUENCY	SAMPLE TYPE
Total Suspended Solids, % removal, minimum	≥ 85% (*2)	N/A	N/A	N/A	N/A	N/A	Once/Week	Calculation (*2)
E. coli Bacteria	N/A	N/A	N/A	126 (*3)	410 (*3)	N/A	Once/Week	Grab
Total Residual Chlorine	N/A	N/A	N/A	N/A	11 µg/l	N/A	Daily	Instantaneous Grab (*4)
Phosphorus, Total	2.16	Report	N/A	0.1	0.15	N/A	Once/Month	24-Hr Composite
Nitrogen, Total, Ti ≥ 13°C (*5, *6, *7)	90.1	Report	N/A	4	4	N/A	Once/2 Weeks	24-Hr Composite
Nitrogen, Total, Ti < 13°C (*5, *6, *8)	135.2	Report	N/A	6	6	N/A	Once/2 Weeks	24-Hr Composite
Nitrogen, Total (*5, *9)	18.9	Report	N/A	1	1.5	N/A	Once/Month	24-Hr Composite

Figure C-33. Ruidoso Effluent Limitations.

C.32 New York

The Onondaga County (New York) Department of Water Environment Protection was issued a State Pollutant Discharge Elimination System (SPDES) Permit to discharge from the Metropolitan Syracuse Wastewater Treatment Plant (Metro) to Onondaga Lake. SPDES Permit No. NY 002 7081, issued by the New York State Department of Environmental Conservation (NYSDEC), has an effective date of March 21, 2012 and expires on March 20, 2017.

Metro serves a combined sewer system and has SPDES permit conditions for two outfalls. Flows up to 126.3 mgd receive tertiary treatment for year round nitrification and phosphorus removal and UV disinfection and are discharged through Outfall 001. Flows above 126.3 mgd up to 240 mgd receive primary treatment and disinfection and are discharged through Outfall 002.

Onondaga Lake was listed as impaired on New York's 1996 303(d) list due to excessive phosphorus loadings to the lake. Metro's SPDES permit contains stringent phosphorus limits based on a 1998 Phase 1 TMDL for phosphorus to Onondaga Lake that primarily addressed loadings from Metro. The current SPDES permit includes12-month rolling average limits for both flow (84.2 mgd) and phosphorus for Outfall 001. Phosphorus limits have been implemented in stages and is summarized in Table C-3.

Table C-3. Onondaga County Phosphorus Limits.

Effective Dates	Phosphorus Limit (12-month rolling average)
May 1, 2004 to March 31, 2006	Interim Limit = 400 lb/day
April 1, 2006 to November 15, 2010	Interim Limit = 0.12 mg/L
November 16, 2010 to December 31, 2015	Interim Limit = 0.10 mg/L
After December 31, 2015	Final Limit = 0.02 mg/L

The current permit requires monitoring for phosphorus but does not set phosphorus limits for Outfall 002.

Permit provisions allow the phosphorus limits to be revised based on subsequent phosphorus TMDLs and allocations. In May 2012 the NYSDEC issued a comprehensive phosphorus TMDL for Onondaga Lake. For Metro, the 2012 TMDL calls for maintaining the final phosphorus limit for Outfall 001 at 0.1 mg/L and adding a bubble annual mass loading limit of 27,212 lb/year for Outfalls 001 and 002 combined, both on a 12-month rolling average basis. Onondaga County is pursuing modifications to the Metro SPDES permit to incorporate the effluent phosphorus limits proposed in the 2012 TMDL.

C.33 North Carolina

The Greenville Utilities Commission (GUC) was issued a permit to discharge from the GUC WWTP to the Tar River, located in the Tar-Pamlico River Basin in coastal, Eastern North Carolina. The current permit became effective on June 1, 2010 and expired on October 31, 2014.

The Tar River and Pamlico Sound are classified as Nutrient Sensitive Waters (NSW) by the State of North Carolina due to chlorophyll-a concentrations exceeding the state water quality standard of 40 µg/L and nutrient enrichment issues in Pamlico Sound. A NSW Implementation Strategy developed for the basin includes TN and TP annual mass loading limits for members of the Tar-Pamlico Basin Association (TPBA), a coalition of 15 municipal wastewater treatment facilities including the GUC WWTP. Annual mass loading limits for the 15 TBPA facilities, which have a total combined permitted flow of 62.35 mgd, include 891,272 lb/year TN and 161,070 lb/year TP.

The GUC WWTP permit includes a monthly average flow limit of 17.5 mgd and seasonal monthly and weekly average ammonia limits. Unique permit conditions are in place for TP and TN mass loadings. In lieu of nutrient limits in individual permits, permit conditions require the TPBA members to collectively meet the annual mass loading limits established in the NSW Implementation Strategy. Though individual permits do not include mass nutrient limits, the TPBA members allocate the annual nutrient loads among themselves and set annual TP and TN effluent targets for each of the 15 member facilities proportional to flow. GUC must conduct weekly monitoring for nutrients and report monthly and annual nutrient mass loadings to demonstrate compliance with the TPBA annual mass loading limits, and to show that they are meeting their individual targets set by the TPBA members. GUC permit conditions are summarized in Table C-4.

Table C-4. Greenville (GUG) Permit Conditions.

Parameter	Monthly Average Limit	Weekly Average Limit
Flow	17.5 mgd	
$CBOD_5$[1]	8.0 mg/L – Summer 15.0 mg/L – Winter	12.0 mg/L –Summer 22.5 mg/L – Winter
TSS	30.0 mg/L	45.0 mg/L
NH_3-N[1]	4.1 mg/L – Summer 8.2 mg/L – Winter	12.3 mg/L – Summer 24.6 mg/L – Winter
D.O.	Daily Average not less than 5.0 mg/L	
Fecal Coliform	200/100 ml	400/100 ml
pH	Between 6.0 and 9.0 Standard Units	
TP[2]	Monitor and Report (mg/L)	
TN[2]	Monitor and Report (mg/L)	
TKN	Monitor and Report (mg/L)	
NO_2-N + NO_3-N	Monitor and Report (mg/L)	

[1]Summer: April 1 – October 31
[2]Subject to Tar-Pamlico Nutrient Sensitive Waters Implementation Strategy: Phase III

C.34 North Dakota

An example nutrient NPDES permit has not been identified for North Dakota.

C.35 Ohio

The Easterly Wastewater Treatment Plant, located in the Northeast Ohio Regional Sewer District in Cleveland, Ohio, was issued a permit to discharge to Lake Erie. The permit OH0024643 was issued by the Ohio EPA. The flow is based on a design flow of 155 mgd. The effluent limitations table from the permit is shown in Figure C-34.

The NPDES permit includes effluent TP. Effluent limits include monthly average and weekly average concentration and load limits. This permit is interesting because it is a large wastewater treatment facility discharging into a large lake with a nutrient permit limit.

		Effluent Limits				
		Concentration		Loading (kg/day)[a]		
Parameter	Units	30 Day Average	Daily Maximum	30 Day Average	Daily Maximum	Basis[b]
Flow	MGD		----------- Monitor -----------		M[c]	
Temperature	°C		----------- Monitor -----------		M[c]	
Dissolved Oxygen	mg/l		----------- Monitor -----------		M[c]	
$CBOD_5$	mg/l	15	22.5[d]	8813	13200[d]	EP
Suspended Solids	mg/l	20	30[d]	11750	17620[d]	BEJ, EP
Ammonia-N	mg/l		----------- Monitor -----------		M[c]	
Phosphorus	mg/l	1.0	1.5[d]	587	881[d]	IJC
Oil and Grease	mg/l		Not to exceed 10 at any time			WQS
pH	S.U.		---------- 6.5 to 9.0 -----------		WQS	
Fecal Coliform						
Summer Only	#/100ml	1000	2000[d]	--	--	WQS
Chlorine Residual						
Summer Only	mg/l		Not to exceed 0.038 at any time			WLA/IMZM
Nitrate(N)	mg/l		----------- Monitor -----------		M[c]	
Nitrite(N)	mg/l		----------- Monitor -----------		M[c]	
Cyanide, Free	mg/l		----------- Monitor -----------		RP	
Cadmium, T. R.	µg/l		----------- Monitor -----------		RP	
Chromium, T. R.	µg/l		----------- Monitor -----------		RP	
Hex. Chromium						
(Dissolved)	µg/l		----------- Monitor -----------		RP	
Copper, T. R.	µg/l		----------- Monitor -----------		RP	
Lead, T. R.	µg/l		----------- Monitor -----------		RP	
Mercury, T.	µg/l	0.012	1.1	0.0007	0.65	AD
Nickel, T. R.	µg/l		----------- Monitor -----------		RP	
Silver, T. R.	µg/l		----------- Monitor -----------		RP	
Zinc, T. R.	µg/l		----------- Monitor -----------		RP	
Bis(2-ethylhexyl)						
phthalate	µg/l		----------- Monitor -----------		RP	
Whole Effluent						
Toxicity						
Acute	TUa		-------- Monitor (w/o trigger) -------			WET
Chronic	TUc		-------- Monitor (w/o trigger) -------			WET

Table 9.

(Continued)

[a] Effluent loadings based on average design discharge flow of 155 MGD.

[b] Definitions: AD = Antidegradation (OAC 3745-1-05); BEJ = Best Engineering Judgment; EP = Existing Permit; IJC = 1988 revision of the 1972 Great Lakes Water Quality Agreement of the International Joint Commission; M = Monitoring; RP = Reasonable Potential for requiring water quality-based effluent limits and monitoring requirements in NPDES permits [OAC 3745-33-07(A)]; WET = reasonable potential for requiring water quality-based effluent limits and monitoring requirements for whole effluent toxicity in NPDES permits [OAC 3745-33-07(B)]; WLA/IMZM = Wasteload Allocation limited by Inside Mixing Zone Maximum; WQS = Ohio Water Quality Standards (OAC 3745-1-07).

[c] Monitoring of flow and other indicator parameters is specified to assist in the evaluation of effluent quality and treatment plant performance.

[d] 7 day average limit.

Figure C-34. Easterly Wastewater Treatment Plant Effluent Limitations.

C.36 Oklahoma

Westville Utility Authority located in Westville, Oklahoma, was issued a permit to discharge to the Shell Branch tributary to the Barren Fork. The permit OK0028126 expired in 2010. The permit was issued by The State of Oklahoma DEQ.

The Westville NPDES permit includes effluent limits for both ammonia and phosphorus. The permit limits are monthly average mass and monthly average and weekly average concentration limits that vary by season. The spring effluent limitations table from the permit is shown in Table C-5, the summer effluent limitations in Table C-6, and the winter effluent limitation in Table C-7.

Table C-5. Westville Utility Authority Spring Effluent Limitations (April 1st through May 31st).

Effluent Characteristics	Discharge Limitations			Monitoring Requirements	
	Mass (lbs/day, unless otherwise specified)	Concentration (mg/l, unless otherwise specified)		Measurement Frequency	Sample Type
	Monthly Average	Monthly Average	Weekly Average		
Carbonaceous Biochemical Oxygen Demand -5 Day ($CBOD_5$) [STORET:80082]	28.0	12	18	2/month	grab[a]
Total Suspended Solids (TSS) [STORET: 00530]	70.1	30	45	2/month	grab[a]
Ammonia (NH_3-N) [STORET:00610]	9.3	4	6	2/month	grab[a]
Phosphorus (P) [STORET:00670]	2.34	1	1.5	2/month	grab[a]
Dissolved Oxygen (DO) [STORET:00300]	NA	6 mg/l MINIMUM		daily	grab[a]
Fecal Coliform[a] (May) [STORET: 74055]	N/A	200 (geometric mean)	400 (daily max)	2/month	grab[a]

[a] Upon completing construction of the new SBR treatment plant, the sample type will change to a single composite SBR sample.

Table C-6. Westville Utility Authority Summer Effluent Limitations (June 1st through October 31st).

Effluent Characteristics	Discharge Limitations			Monitoring Requirements	
	Mass (lbs/day, unless otherwise specified)	Concentration (mg/l, unless otherwise specified)		Measurement Frequency	Sample Type
	Monthly Average	Monthly Average	Weekly Average		
Carbonaceous Biochemical Oxygen Demand -5 Day ($CBOD_5$) [STORET:80082]	23.4	10	15	2/month	grab[a]
Total Suspended Solids (TSS) [STORET: 00530]	35	15	22.5	2/month	grab[a]
Ammonia (NH_3-N) [STORET:00610]	9.3	4	6	2/month	grab[a]
Phosphorus (P) [STORET:00670]	2.34	1	1.5	2/month	grab[a]
Dissolved Oxygen (DO) [STORET:00300]	NA	5 mg/l MINIMUM		daily	grab[a]
Fecal Coliform[a] (June-September) [STORET: 74055]	N/A	200 (geometric mean)	400 (daily max)	2/month	grab[a]

[a] Upon completing construction of the new SBR treatment plant, the sample type will change to a single composite SBR sample.

Table C-7. Westville Utility Authority Winter Effluent Limitations (November 1st through March 31st).

Effluent Characteristics	Discharge Limitations			Monitoring Requirements	
	Mass (lbs/day, unless otherwise specified)	Concentration (mg/l, unless otherwise specified)		Measurement Frequency	Sample Type
	Monthly Average	Monthly Average	Weekly Average		
Carbonaceous Biochemical Oxygen Demand -5 Day ($CBOD_5$) [STORET:80082]	30.4	13	19.5	2/month	grab[a]
Total Suspended Solids (TSS) [STORET: 00530]	70.1	30	45	2/month	grab[a]
Ammonia (NH_3-N) [STORET:00610]	17.5	7.5	11.3	2/month	grab[a]
Phosphorus (P) [STORET:00670]	2.34	1	1.5	2/month	grab[a]
Dissolved Oxygen (DO) [STORET:00300]	NA	4 mg/l MINIMUM		daily	grab[a]

[a] Upon completing construction of the new SBR treatment plant, the sample type will change to a single composite SBR sample.

C.37 Oregon

Clean Water Services (CWS)and the Washington County Department of Land Use and Transportation located in Hillsboro, Oregon, was issued a watershed permit to discharge to the Tualatin River. The permits OR101141, OR141142, OR101143, and OR101144 were issued February 2, 2004. The permit was issued by the Oregon DEQ. CWS operates four municipal wastewater treatment facilities. The flow is based on a design flow for each facility: Durham – 22.6 mgd; Forest Grove – 8.0 mgd (AWTF); Hillsboro – 3.7 mgd; and Rock Creek – 39 mgd. The effluent limitations table from the permit is shown in Figure C-35.

The permit includes effluent ammonia limits consistent with the Tualatin River TMDL. The ammonia removal season is from May 1st through November 15th. The ammonia limits in the permit are weekly median maximum loads. Maximum effluent ammonia concentrations are also included in the permit. The Durham AWTF and Rock Creek AWTF include limits for TP of 0.11 mg/L and 0.10 mg/L, as a monthly median from May through October.

Outfall	Parameter	Weekly Median Maximum Load, lbs/day
Durham AWTF, Rock Creek AWTF	Ammonia - N	Weekly Median Maximum Ammonia Load = (Farmington Flow)(Concentration Variable) (5.39) lbs/day, where: Farmington Flow is the previous calendar weekly consecutive-day median of the daily mean flow at the Farmington gauge in cfs, and Concentration Variable is NH_3-N in mg/L during the applicable period as follows:

Concentration Variable (NH_3-N, mg/L) (The applicable tier is based on the instream dissolved oxygen concentration as described below)		Applicable Time Period
Tier 1	Tier 2	
1.4	1.4	May and June
1.4	0.8	July
1.4	0.3	August
0.8	0.21	September through November 15

The Tier 1 concentration variable is in effect for any week during the applicable period unless the following conditions occur, in which case the Tier 2 concentration variable is in effect.

Month	Maximum Daily Ammonia Effluent Concentration (NH_3-N, mg/L)	Maximum Daily Ammonia Effluent Concentration (NH_3-N, mg/L)
	Rock Creek (Outfall R001)	Durham (Outfall D001)
May	35	26
June	33	22
July	30	19
August	30	19
September	34	24
October	35	28

Figure C-35. Clean Water Services Effluent Limitations.

C.38 Pennsylvania

The Mid Cameron Municipal Authority, located in Emporium, Pennsylvania, was issued an NPDES permit (PA0028631) to discharge from its 1 mgd municipal wastewater treatment plant treatment plant to the Driftwood Branch of Sinnemahoning Creek in the Susquehanna River basin. The NPDES permit, issued by the Pennsylvania Department of Environmental Protection (DEP), has an effective date of December 1, 2012 and an expiration date of November 30, 2017.

The Susquehanna River is the main stem of the Chesapeake Bay, and the NPDES permit includes nitrogen and phosphorus limits based on the WLA assigned to the Authority's treatment plant in the Chesapeake Bay TMDL. Nitrogen and phosphorus limits are expressed as annual mass loads, or cap loads, of 17,100 lb/year TN and 2,140 lb/year TP. It is important to note that annual mass loads are equivalent to annual average concentrations of 5.6 mg/L TN and 0.7 mg/L TP at the 1mgd annual average design flow. However, concentration limits for nitrogen or phosphorus are not included in the permit. Weekly monitoring and monthly report of TN and TP are required, as well as annual reporting of the pounds discharged for the year for each nutrient. Limits and monitoring and reporting requirements are shown in Table C-8.

Table C-8. Mid Cameron Municipal Authority Effluent Limitations and Monitoring Requirements.

Parameter [1]	Effluent Limitations					Monitoring Requirements	
	Mass Units (lbs)		Concentrations (mg/L)			Minimum [2] Measurement Frequency	Required Sample Type
	Monthly	Annual	Minimum	Monthly Average	Maximum		
Ammonia---N	Report	Report		Report		2/week	24-Hr Composite
Kjeldahl---N	Report			Report		1/week	24-Hr Composite
Nitrate-Nitrite as N	Report			Report		1/week	24-Hr Composite
Total Nitrogen	Report	Report		Report		1/month	Calculation
Total Phosphorus	Report	Report		Report		1/week	24-Hr Composite
Net Total Nitrogen	Report	17,100				1/month	Calculation
Net Total Phosphorus	Report	2,140				1/month	Calculation

Pennsylvania has a certified nutrient credit trading and nutrient offset programs. The Authority's permit allows certified nutrient credits obtained through the state's nutrient credit exchange to be applied towards compliance with the annual nitrogen and phosphorus cap loads. Credits generated by the Authority or applied towards compliance are reported monthly and annually. Nutrient offsets must be approved in advance by DEP, and approved offsets are not included in the Authority's permit at this time.

C.39 Rhode Island

East Greenwich WWTF located in the Town of East Greenwich was issued a permit to discharge to Greenwich Cove. The permit RI0100030 expired on October 31, 2016. The permit was issued by the Rhode Island Department of Environmental management. The permit includes an average monthly flow limit of 1.7 mgd. The effluent limitations table from the permit is shown in Figure C-36.

The NPDES permit includes a TN concentration and load effluent limit of 5 mg/L TN and 71 lb/day, respectively.

Effluent Characteristic	Discharge Limitations: Quantity - lbs. per day		Concentration - specify units			Monitoring Requirement	
	Average Monthly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily	Measurement Frequency	Sample Type
Oil and Grease					--- mg/l	1/Month	3 Grabs[1]
Nitrogen, Total (TKN + NO_2-N, +NO_3-N) [November 1 – April 30]	--- lbs./day		--- mg/l		---mg/l	2/Month	Calculated
Nitrogen, Total (TKN + NO_2-N, +NO_3-N) [May 1 – October 31]	71 lbs./day		5.0 mg/l		---mg/l	1/Week	Calculated
TKN [November 1 – April 30]			--- mg/l		--- mg/l	2/Month	24-Hr. Comp.
TKN [May 1 – October 31]			--- mg/l		--- mg/l	1/ Week	24-Hr. Comp.
Nitrite, Total (as N) [Nov 1 – April 30]			--- mg/l		--- mg/l	2/Month	24-Hr. Comp.
Nitrite, Total (as N) [May 1 – Oct 31]			--- mg/l		--- mg/l	1/ Week	24-Hr. Comp.
Nitrate, Total (as N) [Nov 1 – April 30]			--- mg/l		--- mg/l	2/Month	24-Hr. Comp.
Nitrate, Total (as N) [May 1 – Oct 31]			--- mg/l		--- mg/l	1/ Week	24-Hr. Comp.

Figure C-36. East Greenwich Wastewater Treatment Facility Effluent Limitations.

C.40 South Carolina

An example nutrient NPDES permit has not been identified for South Carolina.

C.41 South Dakota

The City of Wagner WWTP was issued a permit to discharge to an unnamed tributary that flows to Choteau Creek. The permit was issued by the South Dakota Department of Environment and Natural Resources. The facility has a maximum flow of 1.64 mgd. The effluent limitations table from the permit is shown in Figure C-37.

The NPDES permit includes interim and final effluent ammonia limits. The interim limits include two effluent seasons (March through October and November through February) with monthly average and daily maximum concentration limits. The final effluent ammonia limits were based on Ammonia Toxicity Model (AMMTOX) modeling software and include monthly average and daily maximum effluent concentrations, with limits that vary by month.

Statement of Basis

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Interim Effluent Ammonia Limits

Since the AMMTOX model results in slightly more stringent limits than the previous permit, the acquisition of creek data from the actual receiving stream rather than relying on data from a "similar" creek, will be beneficial. The permittee shall have the opportunity to request that the new limits outlined in this permit (Table 2) be re-evaluated based on current data prior to the new limits becoming effective. Therefore, as part of this permit, the permittee is requested to monitor the receiving stream (pH, temperature and flow characteristics) at the frequency listed below in the Self-Monitoring requirements. **During this monitoring period, the ammonia limits outlined in the previous permit shall be in effect until three (3) years after the effective date of this permit.**

Parameter	30-Day Average	7-Day Average	Daily Maximum
Ammonia, as N, mg/L			
March 1 - October 31	1.28	n/a	5.43
November 1 - February 29	6.06	n/a	10.38

Final Effluent Ammonia Limits

Table 2 presents the AMMTOX modeling software calculated effluent discharge limits by month of the allowable chronic (30 day average) and acute (daily maximum) ammonia levels expected within the receiving stream and downstream of the discharge point.

Table 2

Month	Chronic 30 Day Avg. (mg/L)	Acute Daily Max. (mg/L)
January	1.6	3.2
February	1.7	3.0
March	1.1	3.0
April	1.1	3.2
May	1.1	3.2
June	0.7	3.2
July	0.7	3.2
August	0.7	3.2
September	0.8	3.2
October	1.1	3.2
November	1.4	3.2
December	1.6	3.2

Stream background assumptions made in model:
- ammonia concentration = 0.01 mg/L
- flow = 0.1 cfs (low flow condition)

Assumed Effluent pH = 8.5 (Value used in model to closer match stream data due to mixing)

Figure C-37. City of Wagner Interim and Final Effluent Ammonia Limits.

C.42 Tennessee

The Cookeville WWTP located in east-central Tennessee was issued a permit to discharge to Pigeon Roost Creek. The permit TN0024198 expired on November 8, 2011. The permit was issued by the Tennessee Department of Environment and Conservation. The flow is based on a design flow of 14 mgd. The effluent limitations table from the permit is shown in Table C-9.

The permit includes an annual mass limit for TN and TP. "The annual average daily loads for TN and TP shall be defined and calculated as the calendar year average of the daily loads (concentrations and their associated flows measured a minimum of weekly) measured during the report period January 1 through December 31." Seasonal loads were rejected by the permit writer. The receiving water is 303(d) but without a TMDL, thus in-order to comply with the anti-degradation provision the permit limits nutrients to the existing load.

Table C-9. Cookeville Wastewater Treatment Plant Effluent Limitations and Monitoring Requirements.

1.0. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1.1. NUMERIC AND NARRATIVE WATER QUALITY/SECONDARY TREATMENT EFFLUENT LIMITATIONS

The City of Cookeville is authorized to discharge treated municipal wastewater from Outfall 001 to the Pigeon Roost Creek Mile 2.3. Discharge 001 consists of municipal wastewater from a treatment facility with a design capacity of 14 MGD. Discharge 001 shall be limited and monitored by the permittee as specified below:

Description : External Outfall, Number : 001, Monitoring : Dry Weather, Season : All Year

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
Overflow use, occurrences	Report	-	occur/mo	Visual	Continuous	Monthly Total

Description : External Outfall, Number : 001, Monitoring : Wet Weather, Season : All Year

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
Bypass of Treatment	Report	-	occur/mo	Visual	Continuous	Monthly Total
Overflow use, occurrences	Report	-	occur/mo	Visual	Continuous	Monthly Total

Description : External Outfall, Number : 001, Monitoring : Effluent Gross, Season : All Year

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
Chlorine, total residual (TRC) *	<=	.02	mg/L	Grab	Five Per Week *	Instantaneous Maximum
E. coli, MTEC-MF	<=	941	#/100mL	Grab	Three Per Week	Daily Maximum
E. coli, MTEC-MF	<=	126	#/100mL	Grab	Three Per Week	Monthly Geometric Mean
Flow	Report	-	Mgal/d	Continuous	Daily	Daily Maximum
Flow	Report	-	Mgal/d	Continuous	Daily	Monthly Average
IC25 Static Renewal 7 Day Chronic Ceriodaphnia	>=	95	%	Composite	Semiannual	Minimum
IC25 Static Renewal 7 Day Chronic Pimephales	>=	95	%	Composite	Semiannual	Minimum
Nitrogen, total (as N)	Report	-	lb/d	Composite	Weekly	Daily Maximum
Nitrogen, total (as N)	Report	-	lb/d	Composite	Weekly	Monthly Average
Nitrogen, total (as N)	Report	-	mg/L	Composite	Weekly	Monthly Average
Nitrogen, total (as N)	Report	-	mg/L	Composite	Weekly	Daily Maximum
Nitrogen, total (as N)	<=	1532	lb/d	Calculated	Annual ***	Daily Average
Oxygen, dissolved (DO)	>=	6	mg/L	Grab	Five Per Week	Instantaneous Minimum

Phosphorus, total (as P)	Report	-	lb/d	Composite	Weekly	Monthly Average
Phosphorus, total (as P)	Report	-	mg/L	Composite	Weekly	Monthly Average
Phosphorus, total (as P)	Report	-	mg/L	Composite	Weekly	Daily Maximum
Phosphorus, total (as P)	Report	-	lb/d	Composite	Weekly	Daily Maximum
Phosphorus, total (as P)	<=	245	lb/d	Calculated	Annual ***	Daily Average
Settleable Solids	<=	1	mL/L	Grab	Weekly **	Daily Maximum
Total Suspended Solids (TSS)	<=	30	mg/L	Composite	Weekly **	Monthly Average
Total Suspended Solids (TSS)	<=	40	mg/L	Composite	Weekly **	Weekly Average
Total Suspended Solids (TSS)	<=	3503	lb/d	Composite	Weekly **	Monthly Average
Total Suspended Solids (TSS)	<=	4607	lb/d	Composite	Weekly **	Weekly Average
Total Suspended Solids (TSS)	<=	45	mg/L	Composite	Weekly **	Daily Maximum
pH	>=	6	SU	Grab	Five Per Week	Minimum
pH	<=	9	SU	Grab	Five Per Week	Maximum

Description : External Outfall, Number : 001, Monitoring : Effluent Gross, Season : Summer

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
CBOD, 5-day, 20 C	<=	10	mg/L	Composite	Weekly **	Monthly Average
CBOD, 5-day, 20 C	<=	20	mg/L	Composite	Weekly **	Daily Maximum
CBOD, 5-day, 20 C	<=	15	mg/L	Composite	Weekly **	Weekly Average
CBOD, 5-day, 20 C	<=	1168	lb/d	Composite	Weekly **	Monthly Average
CBOD, 5-day, 20 C	<=	1751	lb/d	Composite	Weekly **	Weekly Average
Nitrogen, Ammonia total (as N)	<=	1.9	mg/L	Composite	Weekly **	Weekly Average
Nitrogen, Ammonia total (as N)	<=	152	lb/d	Composite	Weekly **	Monthly Average
Nitrogen, Ammonia total (as N)	<=	222	lb/d	Composite	Weekly **	Weekly Average
Nitrogen, Ammonia total (as N)	<=	2.6	mg/L	Composite	Weekly **	Daily Maximum
Nitrogen, Ammonia total (as N)	<=	1.3	mg/L	Composite	Weekly **	Monthly Average

Description : External Outfall, Number : 001, Monitoring : Effluent Gross, Season : Winter

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
CBOD, 5-day, 20 C	<=	2335	lb/d	Composite	Weekly **	Weekly Average
CBOD, 5-day, 20 C	<=	20	mg/L	Composite	Weekly **	Weekly Average
CBOD, 5-day, 20 C	<=	25	mg/L	Composite	Weekly **	Daily Maximum
CBOD, 5-day, 20 C	<=	15	mg/L	Composite	Weekly **	Monthly Average
CBOD, 5-day, 20 C	<=	1751	lb/d	Composite	Weekly **	Monthly Average
Nitrogen, Ammonia total (as N)	<=	4.2	mg/L	Composite	Weekly **	Daily Maximum
Nitrogen, Ammonia total (as N)	<=	2.1	mg/L	Composite	Weekly **	Monthly Average
Nitrogen, Ammonia total (as N)	<=	362	lb/d	Composite	Weekly **	Weekly Average
Nitrogen, Ammonia total (as N)	<=	245	lb/d	Composite	Weekly **	Monthly Average
Nitrogen, Ammonia total (as N)	<=	3.1	mg/L	Composite	Weekly **	Weekly Average

Description : External Outfall, Number : 001, Monitoring : Percent Removal, Season : All Year

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
CBOD, 5-day, 20 C, % removal	>=	40	%	Calculated	Weekly **	Daily Minimum
CBOD, 5-day, 20 C, % removal	>=	85	%	Calculated	Weekly **	Monthly Average Minimum
TSS, % removal	>=	40	%	Calculated	Weekly **	Daily Minimum
TSS, % removal	>=	85	%	Calculated	Weekly **	Monthly Average Minimum

Description : External Outfall, Number : 001, Monitoring : Raw Sewage Influent, Season : All Year

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
CBOD, 5-day, 20 C	Report	-	mg/L	Composite	Weekly **	Daily Maximum
CBOD, 5-day, 20 C	Report	-	mg/L	Composite	Weekly **	Monthly Average
Flow	Report	-	Mgal/d	Continuous	Daily	Monthly Average
Flow	Report	-	Mgal/d	Continuous	Daily	Daily Maximum
Total Suspended Solids (TSS)	Report	-	mg/L	Composite	Weekly **	Daily Maximum
Total Suspended Solids (TSS)	Report	-	mg/L	Composite	Weekly **	Monthly Average

* The chlorine effluent limitation and monitoring only apply if chlorine is used in any portion of the treatment process. Total residual chlorine (TRC) monitoring shall be applicable when chlorine, bromine,

C.43 Texas

The City of Burnet WWTF, located northwest of Austin, Texas, was issued a permit to discharge to Hamilton Creek. The permit WQ0010793002 expired on December 1, 2014. The permit was issued by the Texas Commission on Environmental Quality.

The permit includes interim and final effluent limitations for ammonia nitrogen. The effluent limitations include daily average concentration and load, 7-day average concentration, daily maximum, and single grab (instantaneous) limits. The final effluent limitations include daily average concentration and load limits for ammonia and TN, and daily average concentration and load limits, 7-day average concentration, daily maximum, and single grab (instantaneous) limits for TP. The interim and final effluent limitations tables from the permit are shown in Figure C-38 and Figure C-39, respectively.

City of Burnet TPDES Permit No. WQ0010793002

INTERIM EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS Outfall Number 001

1. During the period beginning upon the date of issuance and lasting through the completion to the 1.7 million gallons per day (MGD) facilities, the permittee is authorized to discharge subject to the following effluent limitations:

   The daily average flow of effluent shall not exceed 0.726 MGD; nor shall the average discharge during any two-hour period (2-hour peak) exceed 1,512 gallons per minute (gpm).

Effluent Characteristic	Discharge Limitations				Minimum Self-Monitoring Requirements Report Daily Avg. & Daily Max.	
	Daily Avg mg/l(lbs/day)	7-day Avg mg/l	Daily Max mg/l	Single Grab mg/l	Measurement Frequency	Sample Type
Flow, MGD	Report	N/A	Report	N/A	Continuous	Totalizing Meter
Carbonaceous Biochemical Oxygen Demand (5-day)	10 (60)	15	25	35	One/week	Composite
Total Suspended Solids	15 (90)	25	40	60	One/week	Composite
Ammonia Nitrogen	3 (18)	6	10	15	One/week	Composite
Total Dissolved Solids	Report (Report)	N/A	Report	N/A	Twice/month	Composite

2. The effluent shall contain a chlorine residual of at least 1.0 mg/l and shall not exceed a chlorine residual of 4.0 mg/l after a detention time of at least 20 minutes (based on peak flow), and shall be monitored daily by grab sample. An equivalent method of disinfection may be substituted only with prior approval of the Executive Director.
3. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored twice per month by grab sample.
4. There shall be no discharge of floating solids or visible foam in other than trace amounts and no discharge of visible oil.
5. Effluent monitoring samples shall be taken at the following location(s): Following the final treatment unit.
6. The effluent shall contain a minimum dissolved oxygen of 5.0 mg/l and shall be monitored once per week by grab sample.

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Figure C-38. City of Burnet Interim Effluent Limitations and Monitoring Requirements.

City of Burnet TPDES Permit No. WQ0010793002

FINAL EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS Outfall Number 001

1. During the period beginning upon the completion to the 1.7 million gallons per day (MGD) facilities and lasting through the date of expiration the permittee is authorized to discharge subject to the following effluent limitations:

The annual average flow of effluent shall not exceed 1.7 MGD; nor shall the average discharge during any two-hour period (2-hour peak) exceed 4,722 gallons per minute (gpm).

Effluent Characteristic	Discharge Limitations				Minimum Self-Monitoring Requirements Report Daily Avg. & Daily Max.	
	Daily Avg mg/l(lbs/day)	7-day Avg mg/l	Daily Max mg/l	Single Grab mg/l	Measurement Frequency	Sample Type
Flow, MGD	Report	N/A	Report	N/A	Continuous	Totalizing Meter
Carbonaceous Biochemical Oxygen Demand (5-day)	5 (71)	10	20	30	Two/week	Composite
Total Suspended Solids	5 (71)	10	20	30	Two/week	Composite
Ammonia Nitrogen	2 (28)	5	10	15	Two/week	Composite
Total Nitrogen	6 (85)	N/A	N/A	N/A	Two/week	Composite
Total Phosphorus	0.5 (7.1)	1	2	3	Two/week	Composite
Total Dissolved Solids	Report (Report)	N/A	Report	N/A	One/week	Composite
E. coli, CFU or MPN/100 ml	126	N/A	394	N/A	Daily	Grab

2. The permittee shall utilize an Ultraviolet Light (UV) system for disinfection purposes. An equivalent method of disinfection may be substituted only with prior approval of the Executive Director.

3. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored once per week by grab sample.

4. There shall be no discharge of floating solids or visible foam in other than trace amounts and no discharge of visible oil.

5. Effluent monitoring samples shall be taken at the following location(s): Following the final treatment unit.

6. The effluent shall contain a minimum dissolved oxygen of 5.0 mg/l and shall be monitored twice per week by grab sample.

7. The annual average flow and maximum 2-hour peak flow shall be reported monthly.

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Figure C-39. City of Burnet Final Effluent Limitations and Monitoring Requirements.

C.44 Utah

The East Canyon Creek WRF, part of the Snyderville Basin Water Reclamation District located east of Salt Lake City in Snyderville, Utah, was issued a permit to discharge to East Canyon Creek. The permit UT0020001 expired on July 31, 2016. The permit was issued by the Utah DEQ. The effluent limitations table from the permit is shown in Figure C-40.

The permit includes annual and seasonal, July through September, loads for TP. The phosphorus load is based on a TMDL.

Parameter	Effluent Limitations					
	Max Monthly Avg	Max Weekly Avg	Daily Min	Daily Max	Annual Load	Seasonal Load
$CBOD_5$, mg/L BOD_5 Min. % Removal	12 85	17 NA	NA NA	NA	NA	NA
TSS, mg/L	25	35	NA	NA	NA	NA
TSS Min. % Removal	85	NA	NA			
Ammonia, mg/L Spring Summer Fall Winter	 6.4 5.4 8.4 7.8	NA	NA	 10.4 10.4 12.2 12.9	NA	NA
Ammonia, lbs Spring Summer Fall Winter	 6,405 5,404 8,407 7,806	NA	NA	NA	NA	NA
Dissolved Oxygen, mg/L	NA	NA	5.0	NA	NA	NA
Total Phosphorus, lbs Summer (July, August, Sept)[a]	NA	NA	NA	NA	NA	322
Total Phosphorus, lbs/year	NA	NA	NA	NA	1969	NA
Oil & Grease, mg/L	NA	NA	NA	10	NA	NA
pH, Standard Units	NA	NA	6.5	9.0	NA	NA
E-Coli, No./100mL	126	158	NA	NA	NA	NA

[a] The summer period for phosphorus is shifted back one month because of specific identification of the critical low flow months in the TMDL relative to phosphorus.

NA – Not Applicable.

Figure C-40. East Canyon Creek Water Reclamation Facility Effluent Limitations.

C.45 Vermont

The Montpelier WWTF located in northeastern Vermont was issued a permit to discharge to Winooski River. The permit VT0100196 expired on December 31, 2012. The permit was issued by the Vermont Department of Environmental Conservation. The flow is based on a design flow of 3.97 mgd. The effluent limitations table from the permit is shown in Figure C-41.

The permit includes an annual mass limit and monthly average concentration for TP. The concentration effluent limitation is based on the requirements of 10 V.S.A. 1266a. The mass annual effluent limitation is based on the Lake Champlain Phosphorus TMDL. The TMDL allocated 7,253 pounds per year to the WWTF.

A. EFFLUENT LIMITS

1. Until December 31, 2012 the permittee is authorized to discharge from S/N 001 - outfall, the Montpelier Wastewater Treatment Facility, to the Winooski River, an effluent whose characteristics shall not exceed the values listed below:

DISCHARGE LIMITATIONS								
Effluent Characteristic	**Annual Limitation**	**Monthly Average**	**Weekly Average**	**Maximum Day**	**Monthly Average**	**Weekly Average**	**Maximum Day**	**Instantaneous Maximum**
		....	(lbs / day)	....	....	Concentration)	....	
Flow (Annual Avg)	3.97 MGD							
Carbonaceous Biochemical Oxygen Demand, 5-day, 20° C		827	1324		25 mg/l	40 mg/l	45 mg/l	
Total Ammonia Nitrogen				Monitor only			Monitor only	
Total Suspended Solids		933	1490		30 mg/l	45 mg/l	50 mg/l	
Total Phosphorus [(a)]	7,253 total pounds				0.8 mg/l			
Settleable Solids								1.0 ml/l
Escherichia coli Bacteria								77/100 ml
pH					Between 6.5 and 8.5 Standard Units			

a) Total Annual Pounds of Phosphorus discharge shall be defined as the sum of all the Total Monthly Pounds of Phosphorus discharged for the calendar year. Total Monthly Pounds of Phosphorus discharged shall be calculated as follows:
(Monthly Average Phosphorus Concentration) x (Total Monthly Flow) x 8.34 (See Total Phosphorus monitoring report form WR43-PO4.)

Figure C-41. Montpelier Wastewater Treatment Facility Effluent Limitations.

C.46 Virginia

The Hampton Roads Sanitation District plant located in southeastern Virginia in Norfolk was issued a permit to discharge to the Elizabeth River and unnamed tributaries to the Elizabeth River, Chesapeake Bay, and Atlantic Ocean. The permit VA0081281 expired on January 27, 2013. The permit was issued by the Virginia DEQ. The flow is based on a design flow of 40 mgd. The effluent limitations table from the permit is shown in Figure C-42.

The permit includes a calendar year concentration limit for TP. The limitations and monitoring requirements table includes the following statement: “In addition to any TN or TP concentrations limits listed above, this facility has TN and TP calendar year load limits associated with this outfall included in the current Registration List under registration number VAN040090, enforceable under the General VPDES Watershed Permit Regulation for TN and TP Discharges and Nutrient Trading in the Chesapeake Watershed in Virginia.”

A. LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning with the permit's effective date and lasting until the permit's expiration date, the permittee is authorized to discharge from outfalls: 001 & 002[h]

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTICS	DISCHARGE LIMITATIONS						MONITORING REQUIREMENTS	
	Monthly Average		Weekly Average		Minimum	Maximum	Frequency	Sample Type
Flow (MGD) [a]	NL		NA		NA	NL	Continuous	Totalizing, Indicating & Recording Equipment
pH (S.U.)	NA		NA		6.0	9.0	1/Day	Grab
BOD_5 (mg/l; kg/d)[c][d]	30	4542	45	6813	NA	NA	3/Week	24-Hr.Comp.
Total Suspended Solids (mg/l; kg/d)[c][d]	30	4542	45	6813	NA	NA	3/Week	24-Hr.Comp.
Total Residual Chlorine (TRC) (mg/l) [b][c]	0.20		2.4		NA	NA	1/Day	Grab
Fecal Coliform (N/CML)[d] [g] [j]	200		NA		NA	NA	1/Week (Between 10 AM & 4 PM)	Grab
Enterococci (N/CML)[i] [j]	35		NA		NA	NA	2/Month (Between 10 AM & 4 PM)	Grab
Total Phosphorus Year-to-Date (mg/l) [f]	NL		NA		NA	NA	1/Month	Calculated
Total Phosphorus- Calendar Year(mg/l) [e] [f]	2.0		NA		NA	NA	1/Year	Calculated
Total Phosphorus (mg/l)	NL		NA		NA	NA	1/Month	24-Hr. Comp.

NA = Not Applicable. NL = No limitation, however, reporting is required.
1 Year= January 1-December 31; reported for each full calendar year

Upon issuance of the permit, Discharge Monitoring Reports (DMRs) shall be submitted to the regional office at the frequency required by the permit regardless of whether an actual discharge occurs. In the event that there is no discharge for the monitoring period, then "no discharge" shall be reported on the DMR.

Figure C-42. Hampton Roads Sanitation District Effluent Limitations and Monitoring Requirements.

C.47 Washington

Spokane County Division of Utilities located in eastern Washington was issued a permit to discharge to the Spokane River. The permit WA-0093317 expires on November 31, 2016. The permit was issued by the Washington Department of Ecology. The flow is based on a design flow of 8 mgd. The effluent limitations table from the permit is shown in Figure C-43.

The permit includes a seasonal March through October mass limit for TP. An alternative limit (shown in Figure C-44) was included that allows for a greater limit for TP with a reduced load of carbonaceous biochemical oxygen demand. A compliance schedule was not included because the facility is new. Effluent limitations for the remaining permitted pollutants is shown in Figure C-45.

S1.A. Effluent limits for the oxygen consuming pollutants implementing the Spokane River and Lake Spokane DO TMDL (as the DO TMDL was submitted & approved).

Effluent Limits: Outfall # 001 Latitude 47.675833 N Longitude -117.3469444 W		
Parameter	**Seasonal Limit Applies March 1 to October 31 See notes f and g**	
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$)	280 pounds/day (lbs/day)	
Total Phosphorus (as P) March 1 to Oct. 31	2.80 lbs/day	
Total Ammonia (as NH_3-N)	**Seasonal Limit**	**Maximum Daily Limit**
For "season" of March 1 to May 31	55.4 lbs/day	16 mg/L
For "season" of June 1 to Sept. 30	14.0 lbs/day	8.0 mg/L
For "season" of Oct. 1 to Oct. 31	55.4 lbs/day	16 mg/L
Parameter	**Average Monthly** [a]	**Average Weekly** [b]
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$), November 1 through February 29	4.2 milligrams/liter (mg/L); 280 lbs/day	6.3 mg/L; 420 lbs/day

Figure C-43. Spokane County Effluent Limits for the Oxygen Consuming Pollutants Implementing the Spokane River and Lake Spokane DO TMDL.

S1.B Alternate effluent limits for oxygen consuming pollutants demonstrated to be equivalent to DO TMDL baseline effluent limits in S1.A

Effluent Limits: Outfall # 001 Latitude 47.675833 N Longitude -117.3469444 W		
Parameter	**Seasonal Limit Applies March 1 to October 31 See notes f and g**	
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$)	133.4 pounds/day (lbs/day) average	
Total Phosphorus (as P) March 1 to Oct. 31	3.34 lbs/day average	
Total Ammonia (as NH_3-N)	**Seasonal Limit**	**Maximum Daily Limit [d]**
For "season" of March 1 to March 31	1067.5 lbs/day average	16mg/L
For "season" of April 1 to May 31	66.7 lbs/day average	16 mg/L
For "season" of June 1 to Sept. 30	16.7 lbs/day average	8.0 mg/L
For "season" of Oct. 1 to Oct. 31	66.7 lbs/day average	16 mg/L
Parameter	**Average Monthly [a]**	**Average Weekly [b]**
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$), November 1 through February 29	2.0 milligrams/liter (mg/L) 133 pounds/day (lbs/day)	---

Figure C-44. Spokane County Alternate Effluent Limits for the Oxygen Consuming Pollutants Demonstrated to be Equivalent to DO TMDL Baseline Effluent Limits.

S1.C. Effluent limits for remaining permitted pollutants

Effluent Limits: Outfall # 001 Latitude 47.675833 N Longitude -117.3469444 W		
Parameter	**Average Monthly [a]**	**Average Weekly [b]**
Total Suspended Solids (TSS)	5 mg/L; 334 lbs/day	7.5 mg/L; 500 lbs/day
Total PCBs see section **S9.C, S12, S13** and footnote **h**		
Parameter	**Daily Minimum**	**Daily Maximum [d]**
pH [e]	7.0 standard units	9.0 standard units
Parameter	**Monthly Geometric Mean**	**Weekly Geometric Mean**
Fecal Coliform Bacteria [c]	200/100 milliliter (mL)	400/100 mL
Parameter	**Average Monthly**	**Daily Maximum [d, i]**
Cadmium (total)	0.076 ug/L	0.233 ug/L
Lead (total)	0.772 ug/L	1.34 ug/L
Zinc (total)	53.8 µg/L	72.6 µg/L
Total Residual Chlorine	16.8 ug/L	33.6 ug/L

Figure C-45. Spokane County Effluent Limits for the Remaining Permitted Pollutants.

C.48 West Virginia

An example nutrient NPDES permit has not been identified for West Virginia.

C.49 Wisconsin

The Little Suamico Sanitary District No. 1 located in the eastern Wisconsin near Green Bay was issued a permit to discharge to the Little Suamico River in the Suamico and Little Suamico Rivers Watershed of the Upper Green Bay Drainage Basin. The permit WI-0031968-06-0 expires on September 30, 2017. The permit was issued by the Wisconsin DNR. The flow is based on a design flow of 0.117 mgd. The effluent limitations table from the permit is shown in Table C-10.

The permit includes interim and final TP effluent limitations. “Interim Phosphorus Limitation: The interim effluent limitation for phosphorus will be determined after the first 12 months of effluent monitoring has been completed. The limitation shall equal the upper 99th percentile of representative daily discharge concentrations (one–day P99) as calculated in s. NR 106.05(5)(a), Wis. Adm. Code, and will be expressed as a daily maximum concentration. Imposition of that numerical effluent limitation in this permit will occur without public notice thereof.”

“Final Phosphorus Effluent Limitations: The final calculated effluent limitations for phosphorus are 0.075 mg/L and 0.094 lbs/day as six-month averages and 0.225 mg/L as a monthly average. The final effluent limitations are included for informational purposes only and do not take effect until the next permit reissuance. The limitations may be recalculated at the next reissuance based on additional data or new information.”

Table C-10. Little Suamico Sanitary District No. 1 Effluent Limitations and Monitoring Requirements.

2.2.1 Sampling Point (Outfall) 004 - Effluent, RGF System

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate	Monthly Avg	0 MGD	Daily	Continuous	January, February and March – Discharge not permitted during these months.
		0.217 MGD			April
		0.148 MGD			May
		0.183 MGD			June
		0.09 MGD			July
		0.065 MGD			August
		0.203 MGD			September, October and November
		0.04 MGD			December
BOD_5, Total	Weekly Avg	45 mg/L	2/Week	24-Hr Flow Prop Comp	April and May
		24 mg/L			June
		26 mg/L			July
		25 mg/L			August
		17 mg/L			September
		22 mg/L			October
		31 mg/L			November
		34 mg/L			December
	Weekly Avg	37 lbs/day		Calculated	June
		19 lbs/day			July
		13 lbs/day			August
		28 lbs/day			September
		38 lbs/day			October
		53 lbs/day			November
		11 lbs/day			December

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
BOD_5, Total	Monthly Avg	30 mg/L	2/Week	24-Hr Flow Prop Comp	April, May, November and December
		24 mg/L			June
		26 mg/L			July
		25 mg/L			August
		17 mg/L			September
		22 mg/L			October
Suspended Solids, Total	Weekly Avg	45 mg/L	2/Week	24-Hr Flow Prop Comp	April and May
		24 mg/L			June
		26 mg/L			July
		25 mg/L			August
		17 mg/L			September
		22 mg/L			October
		31 mg/L			November
		34 mg/L			December
	Monthly Avg	30 mg/L			April, May, November and December
		24 mg/L			June
		26 mg/L			July
		25 mg/L			August
		17 mg/L			September
		22 mg/L			October
pH Field	Daily Min	6.0 su	5/Week	Grab	See Section 2.2.1.1.
	Daily Max	9.0 su			
Nitrogen, Ammonia (NH_3-N) Total	Daily Max - Variable	mg/L	2/Week	24-Hr Flow Prop Comp	See Section 2.2.1.1.
	Weekly Avg	28 mg/L			April
		14 mg/L			May
		13 mg/L			June, July, August and December
		10 mg/L			September
		8.6 mg/L			October
		15 mg/L			November
	Monthly Avg	11 mg/L			July and December
		12 mg/L			August
		8.6 mg/L			September
		6.6 mg/L			October
		13 mg/L			November
Dissolved Oxygen	Daily Min	7.0 mg/L	5/Week	Grab	
Phosphorus, Total		mg/L	Weekly	24-Hr Flow Prop Comp	Monitoring only through October 2013.
	Daily Max	mg/L			Interim limit effective November 1, 2013. See Section 2.2.1.2.

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Temperature Maximum			3/Week	Measure	Monitoring only through September 2015. See Sections 2.2.1.3 and 2.2.1.4.
	Daily Max	96 deg F			June, August and November; effective November, 2015. See Section 2.2.1.4.
		99 deg F			July; effective 2016. See Section 2.2.1.4.
		91 deg F			September; effective 2016. See Section 2.2.1.4.
		95 deg F			October; effective 2015. See Section 2.2.1.4.
	Weekly Avg	78 deg F			April; effective 2016. See Sections 2.2.1.4 and 2.2.1.5.
		84 deg F			May and June; effective 2016. See Sections 2.2.1.4 and 2.2.1.5.
		93 deg F			July and August; effective 2016. See Sections 2.2.1.4 and 2.2.1.5.
		80 deg F			September; effective 2016. See Sections 2.2.1.4 and 2.2.1.5.
		67 deg F			October; effective 2015. See Sections 2.2.1.4 and 2.2.1.5.
		57 deg F			November; effective 2015. See Sections 2.2.1.4 and 2.2.1.5.
		86 deg F			December; effective 2015. See Sections 2.2.1.4 and 2.2.1.5.
Chronic WET		rTU_c	See Listed Qtr(s)	24-Hr Flow Prop Comp	See Section 2.2.1.6 for WET testing schedule and requirements.

C.50 Wyoming

The Sheridan WWTP, located in northeast Wyoming was issued a permit to discharge to Goose Creek. The permit WY0020010 expired on May 31, 2013. The permit was issued by the Wyoming DEQ. The flow is based on a design flow of 4.4 mgd plus 0.16 mgd from a local campground for a total flow of 4.416 mgd. The final permit effluent limits are shown in Figure C-46.

The NPDES permit includes monthly average and daily maximum ammonia limits. The limits are applied over two seasons, May through September and October through April.

	Effluent Concentration		
Parameter	Monthly Average (b)	Weekly Average (b)	Daily Maximum (b)
Biochemical Oxygen Demand (BOD), mg/l	30	45	90
BOD, % removal	85	N/A	N/A
E. coli, colonies/100 ml (b), April-Sept	126	N/A	576
E. coli, colonies/100 ml (b), Oct-April	630	N/A	630
Total Suspended Solids (TSS), mg/l	30	45	90
TSS, % removal	85	N/A	N/A
Ammonia, Total as N, mg/l, May-Sept	1.78	N/A	3.56
Ammonia, Total as N, mg/l, Oct-April	9.51	N/A	19.02
Total Residual Chlorine, mg/l	N/A	N/A	0.02
Flow, MGD	4.4	N/A	N/A

Figure C-46. Sheridan Wastewater Treatment Plant Final Permit Effluent Limits.

C.51 Washington, D.C.

DC Water located in the southeastern part of Washington, D.C., was issued a permit to discharge to receiving waters named Potomac and Anacostia Rivers, Rock Creek, and tributary waters. The permit DC0021199 expired on September 30, 2015. The permit was issued by the U.S. EPA Region 3. The flow is based on a design flow of 370 mgd. The effluent limitations table from the permit is shown in Table C-11.

The permit includes average monthly and average weekly mass and concentration limits for TP for a 12-month rolling average. The limits are based on the Potomac Strategy Management Commission Agreement and the best technical information available at the time of permit issuance.

The permit includes an annual mass load for TN. There is a compliance schedule to begin compliance with this TN effluent limit by January 1, 2015. The load is to be calculated on a daily basis as the mass load of the sum of the daily organic nitrogen, ammonia nitrogen, and nitrate.

Table C-11. DC Water Effluent Limitations and Monitoring Requirements Outfall 002.

SECTION B. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS OUTFALL 002

Effluent limitations are based upon the design capacity of 370 mgd for Complete Treatment. During the period beginning on the effective date of the permit and lasting through the expiration date, the permittee is authorized to discharge from Outfall 002 to the Potomac River, subject to the following conditions, discharge limitations and monitoring requirements:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	(lb/day)		Other Units (specify)		Measurement Frequency	Sample Type
	Ave. Monthly	Ave. Weekly	Ave. Monthly	Ave. Weekly		
Flow/day (mgd) (1, 1a,)	N/A (2)	N/A	N/L (3)	N/L	Continuous	Measured
Carbonaceous Biological Oxygen Demand (5 day)	15,429	23,143	5.0 mg/l	7.5 mg/l	Daily	24-hour Composite
Total Suspended Solids (TSS)	21,600	32,400	7.0 mg/l	10.5 mg/l	Daily	24-hour composite
Total Phosphorus	555 (4)	1,080	0.18 mg/l (4)	0.35 mg/l	Daily	24-hour composite
Ammonia Nitrogen:						
Summer (5/1 – 10/31)	12,960	18,823	4.2 mg/l	6.1 mg/l	Daily	24-hour composite
Winter 1 (11/1 – 2/14)	34,253	45,670	11.1 mg/l	14.8 mg/l	Daily	24-hour composite
Winter 2 (2/15 – 4/30)	39,500	52,460	12.8 mg/	17.0 mg/l	Daily	24-hour composite
Dissolved Oxygen	5.0 mg/l minimum daily average. Not less than 4.0 mg/l at any time				Every 2 hours	
Total Residual Chlorine (mg/l) (6)	Non-detectable		Non-detectable		Every 2 hours	Grab
pH (s.u.) (7)	Within limits of 6.0 to 8.5 standard units				Continuous in-situ monitoring and recording	
Total Ortho-phosphate (mg/l)	N/A	N/A	N/L	N/L	Daily	24-hour composite
Alkalinity, total ($CaCO_3$) (mg/l)	N/A	N/A	N/L	N/L	Daily	24-hour composite
Hardness, total ($CaCO_3$) (mg/l)	N/A	N/A	N/L	N/L	Daily	24-hour composite
Nitrite (NO_2) (mg/l)	N/A	N/A	N/L	N/L	Daily	24-hour composite

Nitrate (NO_3) Total Kjeldahl	N/A	N/A	N/L	N/L	Daily	24-hour composite
Nitrogen (mg/l) (10)	N/A	N/A	N/L	N/L	Daily	24-hour composite
Total Nitrogen (mg/l) (10)					Daily	24-hour composite
Cadmium (dissolved) (9)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24-hours
Copper (dissolved (9)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24-hours
Iron (dissolved) (9)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24 hours
Mercury (total recoverable) (8)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24 hours
Lead (dissolved) (9)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24 hours
Nickel (dissolved) (9)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24 hours
Zinc (dissolved) (9)	N/A	N/A	N/L	N/L	Bimonthly	4 grabs/24 hours
PCBs (12)	N/A	N/A			2 wet and 2 dry weather samples quarterly	24-hour composite
E. coli (maximum 30-day geometric mean for 5 samples minimum)	N/A	N/A	126 cfu/100 ml Geometric mean	N/L	1 /day	Grab

(1)Conditions and limitations for flows discharged from Outfall 002 shall be as follows:

APPENDIX D

NPDES PERMIT WRITERS' WORKSHOP FOR NUTRIENT PERMITTING

D.1 Purpose

The purpose of this guideline document is to provide a training workshop with information about including nutrient limits in NPDES permits. The workshop will include topics such as nutrient criteria, treatment technology for low effluent nutrients, and effluent chemistry in relation to receiving water quality. This guideline is useful for a wide audience including regulated entities and especially permit writers. The information contained in this document is intended to supplement and support other permit writer guidelines. The attachments include a sample workshop agenda, annotated agenda describing the workshop modules, and an example workshop exercise.

D.2 Introduction

Excessive nitrogen and phosphorus loadings to watersheds impact water quality by stimulating the growth of algae which may result in depletion of DO, shifts in pH, degradation of habitat, impairment of drinking water sources, and in some cases harmful algal blooms. Nutrient loadings from both point and nonpoint sources contribute to water quality impairments in the nation's waterways. Point source discharges from wastewater treatment plants with limited nutrient treatment can be a significant source of nitrogen and phosphorus in watersheds. Nonpoint sources contribute substantial amounts of nutrients from land use activities such as agriculture, forestry, and urban/suburban development.

Nutrient levels in lakes, streams, and estuaries that do not cause eutrophic conditions are associated with low concentrations. These low concentrations are challenging to meet with treatment of point sources and application of BMPs to nonpoint sources. Nutrient removal treatment, including biological nutrient removal and tertiary treatment, can substantially reduce point source discharges of nitrogen and phosphorus, however substantial investments are required to build and operate advanced wastewater treatment facilities.

Point sources are regulated through NPDES permits. The effluent limitations included in NPDES permits serve as the basis for process upgrades and changes in treatment technology at wastewater treatment plants. Information that goes into the nutrient criteria and/or TMDL development can influence the effluent limits. How the effluent limits are structured in the permit, such as daily maximum, weekly, monthly, seasonal average limits as concentration or load, drives conservative assumptions in the treatment plant design. This in turn is reflected in capital and operations and maintenance costs. Alternate permit structures, such as long-term averages and load limits may provide equivalent environmental benefits to water quality while providing operational flexibility and permit limits that are more reliable to meet, require lower investment costs, and have lower net environmental costs.

D.3 Nutrient Discharge Permitting

Nutrients are different in terms of treatment, WQS, and impact to the receiving water compared to other effluent parameters, in particular toxic parameters. However, much of the existing EPA permit writer's guidance is based on toxics control with few guidelines addressing nutrients (EPA, 1991). NPDES discharge permit structures for nutrients can be based on long averaging periods, such as seasonal limits based on mean or median statistics. It is important that consideration be given to variability and reliability of effluent performance from advanced nutrient removal facilities. These technologies can reduce phosphorus to below 0.1 mg/L and TN to below 5 mg/L. While the technologies are highly effective in nutrient removal, there is inherent variability in effluent quality, particularly at low phosphorus and nitrogen concentrations. The long-term average effluent concentrations can be below these concentrations and meet the water quality requirements but the effluent dataset may include individual discharges with concentrations that are higher. It is important that this operational variability be considered during the permitting process.

Applying toxic permitting criteria for nutrients combines improbable coincident events, such as statistical extremes occurring in both receiving waters and effluent discharge quality. This can result in specifying nutrient permit limits beyond the capabilities of treatment technology and present permit compliance issues for wastewater utilities.

D.4 Understanding Nutrient Impacts on Water Quality

Criteria for addressing nutrient impairment vary by state and region.

- Most states have narrative nutrient criteria that call for maintaining fishable/swimmable waterbody status.
- Following EPA's direction, states are in various stages of developing numeric nutrient criteria.
- Few states have approved criteria with updated NPDES permits to reflect the new criteria. Most states are in the process of drafting new criteria.

Water quality TMDL and permitting NPDES programs are often administered by separate staff groups within regulatory agencies. Communication about the intent of water quality endpoints and the specifics required for the preparation of an NPDES permit are essential. The permitting authority is responsible for interpreting the WQS and TMDLs to develop the effluent limitations for the discharge. Since NPDES permit writers may not be involved with the development of WQS, such as numeric nutrient endpoints, there is the potential for a lack of understanding of the underlying water quality issues associated with the intended protection of beneficial uses.

Nutrient Permitting Training Session

The purpose of this agenda is to provide NPDES permit writers and other interested entities with a summary of topics that influence wastewater discharge permitting, including water quality, advanced wastewater treatment for nutrient removal, watershed management, and sustainability.

By the end of this training, participants will be able to:

- Describe how nutrient limitations are included in NPDES permits.
- Explain how numeric nutrient criteria and TMDLs provide a baseline for nutrient limitation in NPDES permits.
- Identify the changes in effluent variability, nutrient speciation, and bioavailability of nutrients following advanced wastewater treatment.
- Review how permit structure and content can be modified to incorporate effluent quality from advanced wastewater treatment.
- Connect water quality model outcomes to support permit development.
- Write alternative NPDES permit structures that provide the same or similar water quality benefit but may provide different operations strategies for wastewater treatment plants.

NPDES Permit Writers' Workshop for Nutrient Permitting Agenda

Introductions	8:00-8:15
Workshop Agenda and Learning Outcomes	8:15-8:30
Opening Exercise: Nutrient Regulations and Permitting	8:30-9:15
Module One: Permit Structure Variation	9:15-10:15
Break	10:15-10:30
Module Two: Receiving Water (water quality specialist)	10:30-11:30
Lunch	11:30-12:30
Module Three: Effluent (treatment technologist)	12:30-2:00
Module Four: Watershed Management (modeling and regulatory)	2:00-3:00
Break	3:00-3:15
Module Five: Case Studies	3:15-4:00
Closing Exercise: Nutrient Permitting	4:00-4:45
Workshop Conclusion	4:45-5:00

Table D-1. Instructional Design for the NPDES Permit Writers' Workshop for Nutrient Permitting.

Module No. and Topic Trainer	Objectives and Content	Examples or Case Study	Assessment/Evaluation
Opening Exercise.	Review permitting scenario and determine effluent permit limits and permit structure.	-	• Attendees will describe and define NPDES permitting and permit structure in opening activity. • Facilitators will discuss general preconceptions about nutrient permitting.
1. Permit Structure Variation. Trainer: NPDES Permit Writer.	Review five permits with varying effluent limits tables for nutrients. • Permits may include effluent limits tables with the following structure: ○ Monthly and weekly average, mass and concentration. ○ Median. ○ Rolling 12-month average. ○ Seasonal mass. ○ Geometric mean. Information in Modules 2-5 will reference the permits presented in this Module.	• City of Boise. • Clean Water Services. • Metropolitan Council (MCES) – Metropolitan Treatment Plant. • City of Coeur d'Alene. • NAVFAC Hawaii. Wastewater Treatment Plant.	• Facilitators will present a variety of permit structures to the group. • Attendees will describe the differences in nutrient permitting.
2. Receiving Water. Trainer: Water Quality Specialist.	• Nutrient Criteria. ○ Describe numeric nutrient criteria development status. ○ Give examples of current nutrient criteria status for the example permits. • TMDLs ○ Describe water quality basis from TMDL.	• Wisconsin, Montana, Colorado nutrient criteria. • Lower Boise River TMDL. • Lake Pepin Eutrophication Criteria. • Spokane River TMDL.	• Attendees will explain status of nutrient criteria development in their area, nutrient criteria are incorporated into permits, and how TMDLs are incorporated into permits. • Facilitators will provide example TMDLs that allowed for alternate permit structures.

<table>
<tr><th>Module No. and
Topic Trainer</th><th>Objectives and Content</th><th>Examples or Case Study</th><th>Assessment/Evaluation</th></tr>
<tr><td>3. Wastewater Treatment Performance Capabilities.

Trainer: Treatment Technologist.</td><td>Objectives: Technology transfer to foster understanding of nutrient removal treatment.
Nutrient Speciation.
Define phosphorus and nitrogen species.
Describe treatment processes to remove various phosphorus and nitrogen species.
Discuss permitting and operations impacts from refractory compounds.
Bioavailability.
Current bioavailability research including decreased bioavailability with increased levels of treatment.
Technology Performance Statistics.
Average.
Median.
95th Percentile.
Best Performance.
Sustainability.
Increased power use, chemical consumption, greenhouse gas production, and biosolids handling with increased levels of treatment.
Compare relative water quality benefit with environmental impacts and costs associated with advanced treatment.</td><td>Spokane River and Onondaga Lake. bioavailability considerations
Application of TPS to NPDES permit (e.g. Clean Water Services – watershed NPDES permit).
WERF Striking the Balance between Nutrient Removal, Greenhouse Gas Emissions, Receiving Water Quality, and Costs.</td><td>Attendees will identify impacts that changes in treatment technology have on effluent wastewater characteristics.
Facilitators will work with attendees to describe how permit structure could b modified to address these differences.</td></tr>
<tr><td>4. Watershed Management.

Trainers: Water Quality Modeler and NPDES Permit Writer.</td><td>Describe how receiving water criteria and NPDES permitting can be linked through modeling.
What water quality models are available and how can they be used to support both TMDL development and understanding of wastewater treatment scenarios to meet water quality endpoints.
Permitting.
How the permit is structured impacts wastewater operations, conservatism of design, and flexibility in overall watershed management</td><td>AQUATOX Model on Lower Boise River.
Yellowstone River.</td><td>Attendees will review water quality model outcomes to support permit development.
Facilitators will describe how modeling applications may have varied with a different model selection.</td></tr>
</table>

Module No. and Topic Trainer	Objectives and Content	Examples or Case Study	Assessment/Evaluation
	• Water Quality Trading /Offsets.		
5. Case Studies. Trainer:	• Summarize three to five case studies including information on water quality regulations, TMDLs, modeling, and permitting. Objective: combine information from each module and summarize real-life scenario.	-	-
Closing Exercise.	Review permitting scenario and determine effluent permit limits and permit structure based on information reviewed during the training session.	-	• Attendees will repeat the opening exercise to describe and define NPDES permitting and permit structure based on information in workshop • Facilitators will discuss how changes in permit structure can benefit both water quality and wastewater treatment operations

D.5 Continuing Education Credits

HDR is a Registered Provider of continuing education with the American Institute of Architects.

HDR has been accredited as an Authorized Provider by the International Association for Continuing Education and Training (IACET). In obtaining this accreditation, HDR has demonstrated that it complies with the American National Standards Institute (ANSI) standard which is recognized internationally as a standard of good practice. As a result of their Authorized Provider status, HDR is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.

HDR can only approve courses for professional development hour (PDH) credits that are written and delivered by HDR staff. HDR has been conducting continuing education activities for more than ten years and understands the requirements of all 50 U.S. states and Canadian provinces. This course can be modified to meet specific continuing education requirements.

NPDES Permit Writers' Training Exercise for Nutrient Permitting

Opening Exercise

Time Limit: 20 minutes

Instructions: Review the scenario, answer the questions, and fill in the effluent limits table. 40CFR122.45 (Calculating NPDES Permit Conditions) are provided as an attachment for reference.

Scenario
A nutrient TMDL has established a WLA for phosphorus for point sources. The in-stream concentration phosphorus target is 0.100 mg/L TP. City Wastewater Treatment Plant has a design flow of 10 mgd and currently operates enhanced biological phosphorus removal and achieves an average effluent TP concentration of 1 mg/L.

The Blue River was listed as impaired based on state's narrative nutrient criteria for excess algal growth. Point sources and nonpoint sources supply nutrients to the river. The Blue River TMDL included a WLA for City Wastewater Treatment Plant of 8.34 lb/day. In addition to point source reduction, the TMDL included a nonpoint source reduction requirement of 60 percent to meet the in-stream water quality target. The Blue River is impaired during the summer season, May 1 through September 30 with limited excess growth in the winter months.

There are no phosphorus limits in the current NPDES permit.

Exercise

Objective: Prepare effluent limits table for an NPDES permit based on the scenario above. Answer the following questions and fill in Table D-2 Final Effluent Limits:

1. *Are both mass and concentration limits required for this scenario, or are one or the other adequate?*
2. *Are seasonal or year round limits required?*
3. *Is seasonal limitation of TP alone adequate?*
4. *Are there other formulations of the effluent limits that would be appropriate?*

Table D-2. Final Effluent Limits.

Final Effluent Limits – Outfall 001				
Parameter	**Units**	**Average Monthly Limit**	**Average Weekly Limit**	**Maximum Daily Limit**
Summer Season May 1 to September 30				
Total Phosphorus as P	mg/L			
	lb/day			
Orthophosphate as P	mg/L			
	lb/day			
Winter Season October 1 to April 30				
Total Phosphorus as P	mg/L			
	lb/day			
Orthophosphate as P	mg/L			
	lb/day			

NOTES:

Closing Exercise

Time Limit: 20 minutes

Instructions: Review the scenario, answer the questions, and fill in the effluent limits tables. 40CFR122.45 (Calculating NPDES Permit Conditions) are provided as an attachment for reference.

Scenario

A nutrient TMDL has established a WLA for phosphorus for point sources. The in-stream concentration phosphorus target is 0.100 mg/L TP. City Wastewater Treatment Plant has a design flow of 10 mgd and currently operates enhanced biological phosphorus removal and achieves an average effluent TP concentration of 1 mg/L.

The Blue River was listed as impaired based on state's narrative nutrient criteria for excess algal growth. Point sources and nonpoint sources supply nutrients to the river. The Blue River TMDL included a WLA for City Wastewater Treatment Plant of 8.34 lb/day. In addition to point source reduction, the TMDL included a nonpoint source reduction requirement of 60 percent to meet the in-stream water quality target. The Blue River is impaired during the summer season, May 1 through September 30 with limited excess growth in the winter months.

There are no phosphorus limits in the current NPDES permit.

Exercise

Objective: Consider preparing NPDES permit limits that provide the maximum degree of flexibility possible to satisfy the TMDL, including the time required to construct advanced treatment, variability in advanced treatment performance, watershed approaches such as water quality offsets and trading, and opportunities for adaptive management to alter and improve the ability to satisfy the TMDL with time.

Prepare effluent limits table(s) for an NPDES permit based on the scenario above. Answer the following questions and select a Final Effluent Limits table to complete (options shown in Tables 2, 3, and 4) and if appropriate, select an Interim Limits table (options shown in Tables 5, 6, and 7).

1. *Are both mass and concentration limits required for this scenario, or are one or the other adequate?*
2. *Are seasonal or year round limits required?*
3. *Is seasonal limitation of TP alone adequate?*
4. *Are there other formulations of the effluent limits that would be appropriate?*

Select 1 Final Limits table from the options in Tables D-3 through D-5 and fill in the effluent limits.

Optional Table D-3. Final Effluent Limits1.

Parameter	Units	Average Monthly Limit	Average Weekly Limit	Maximum Daily Limit
Summer Season May 1 to September 30				
TP as P	mg/L			
TP as P	lb/day			
OP as P	mg/L			
OP as P	lb/day			
Winter Season October 1 to April 30				
TP as P	mg/L			
TP as P	lb/day			
OP as P	mg/L			
OP as P	lb/day			

[1] New limits apply on effective date of permit.

Optional Table D-4. Final Effluent Limits1.

Parameter	Units	Seasonal Average Limit
Summer Season May 1 to September 30		
TP as P	lb/day	
OP as P	lb/day	
Winter Season October 1 to April 30		
TP as P	lb/day	
OP as P	lb/day	

[1]New limits apply on effective date of permit.

Optional Table D-5. Final Effluent Limits1.

Parameter	Units	Seasonal Average Limit
Summer Season May 1 to September 30		
TP as P	lb/day	
OP as P	lb/day	
Winter Season October 1 to April 30		
TP as P	lb/day	
OP as P	lb/day	

[1]New limits apply following the schedule of compliance.

NOTES:

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Select 1 Interim Limits table from Tables D-6 through D-9.

Optional Table D-6. Interim Effluent Limits.

Parameter	Units	Seasonal Average Limit
Annual Average		
TP as P	lb/day	83.4
TP as P[1]	mg/L	1

[1]Effluent TP concentration does not exceed 1 mg/L.

Optional Table D-7. Final Effluent Limits.

Parameter	Units	Monthly Average Limit
January 1 to December 31		
TP as P	lb/day	83.4

Optional Table D-8. Final Effluent Limits.

Parameter	Units	Seasonal Average Limit
Summer Season May 1 to September 30		
TP as P[1]	lb/day	41.7
Winter Season October 1 to April 30		
TP as P	lb/day	83.4

[1]Effluent TP concentration does not exceed 1 mg/L.

Optional Table D-9. Final Effluent Limits.

Parameter	Units	Monthly Average Limit
Summer Season May 1 to September 30		
TP as P[1]	mg/L	0.5
Winter Season October 1 to April 30		
TP as P	mg/L	1.0

NOTES:

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Attachment A: 40 CFR 122.45 – Calculating NPDES Permit Conditions

§122.45 Calculating NPDES permit conditions (applicable to State NPDES programs, see §123.25).

(a) *Outfalls and discharge points.* All permit effluent limitations, standards and prohibitions shall be established for each outfall or discharge point of the permitted facility, except as otherwise provided under §122.44(k) (BMPs where limitations are infeasible) and paragraph (i) of this section (limitations on internal waste streams).

(b) *Production-based limitations.* (1) In the case of POTWs, permit effluent limitations, standards, or prohibitions shall be calculated based on design flow.

(2)(i) Except in the case of POTWs or as provided in paragraph (b)(2)(ii) of this section, calculation of any permit limitations, standards, or prohibitions which are based on production (or other measure of operation) shall be based not upon the designed production capacity but rather upon a reasonable measure of actual production of the facility. For new sources or new dischargers, actual production shall be estimated using projected production. The time period of the measure of production shall correspond to the time period of the calculated permit limitations; for example, monthly production shall be used to calculate average monthly discharge limitations.

(ii)(A)(*1*) The Director may include a condition establishing alternate permit limitations, standards, or prohibitions based upon anticipated increased (not to exceed maximum production capability) or decreased production levels.

(*2*) *For the automotive manufacturing industry* only, the Regional Administrator shall, and the State Director may establish a condition under paragraph (b)(2)(ii)(A)(*1*) of this section if the applicant satisfactorily demonstrates to the Director at the time the application is submitted that its actual production, as indicated in paragraph (b)(2)(i) of this section, is substantially below maximum production capability and that there is a reasonable potential for an increase above actual production during the duration of the permit.

(B) If the Director establishes permit conditions under paragraph (b)(2)(ii)(A) of this section:

(*1*) The permit shall require the permittee to notify the Director at least two business days prior to a month in which the permittee expects to operate at a level higher than the lowest production level identified in the permit. The notice shall specify the anticipated level and the period during which the permittee expects to operate at the alternate level. If the notice covers more than one month, the notice shall specify the reasons for the anticipated production level increase. New notice of discharge at alternate levels is required to cover a period or production level not covered by prior notice or, if during two consecutive months otherwise covered by a notice, the production level at the permitted facility does not in fact meet the higher level designated in the notice.

(*2*) The permittee shall comply with the limitations, standards, or prohibitions that correspond to the lowest level of production specified in the permit, unless the permittee has notified the Director under paragraph (b)(2)(ii)(B)(*1*) of this section, in which case the permittee shall comply with the lower of the actual level of production during each month or the level specified in the notice.

(*3*) The permittee shall submit with the DMR the level of production that actually occurred during each month and the limitations, standards, or prohibitions applicable to that level of production.

(c) *Metals.* All permit effluent limitations, standards, or prohibitions for a metal shall be expressed in terms of "total recoverable metal" as defined in 40 CFR part 136 unless:

(1) An applicable effluent standard or limitation has been promulgated under the CWA and specifies the limitation for the metal in the dissolved or valent or total form; or

(2) In establishing permit limitations on a case-by-case basis under §125.3, it is necessary to express the limitation on the metal in the dissolved or valent or total form to carry out the provisions of the CWA; or

(3) All approved analytical methods for the metal inherently measure only its dissolved form (e.g., hexavalent chromium).

(d) *Continuous discharges.* For continuous discharges all permit effluent limitations, standards, and prohibitions, including those necessary to achieve WQS, shall unless impracticable be stated as:

(1) Maximum daily and average monthly discharge limitations for all dischargers other than publicly owned treatment works; and

(2) Average weekly and average monthly discharge limitations for POTWs.

(e) *Non-continuous discharges.* Discharges which are not continuous, as defined in §122.2, shall be particularly described and limited, considering the following factors, as appropriate:

(1) Frequency (for example, a batch discharge shall not occur more than once every 3 weeks);

(2) Total mass (for example, not to exceed 100 kilograms of zinc and 200 kilograms of chromium per batch discharge);

(3) Maximum rate of discharge of pollutants during the discharge (for example, not to exceed 2 kilograms of zinc per minute); and

(4) Prohibition or limitation of specified pollutants by mass, concentration, or other appropriate measure (for example, shall not contain at any time more than 0.1 mg/1 zinc or more than 250 grams (¼ kilogram) of zinc in any discharge).

(f) *Mass limitations.* (1) All pollutants limited in permits shall have limitations, standards or prohibitions expressed in terms of mass except:

(i) For pH, temperature, radiation, or other pollutants which cannot appropriately be expressed by mass;

(ii) When applicable standards and limitations are expressed in terms of other units of measurement; or

(iii) If in establishing permit limitations on a case-by-case basis under §125.3, limitations expressed in terms of mass are infeasible because the mass of the pollutant discharged cannot be related to a measure of operation (for example, discharges of TSS from certain mining operations), and permit conditions ensure that dilution will not be used as a substitute for treatment.

(2) Pollutants limited in terms of mass additionally may be limited in terms of other units of measurement, and the permit shall require the permittee to comply with both limitations.

(g) *Pollutants in intake water.* (1) Upon request of the discharger, technology-based effluent limitations or standards shall be adjusted to reflect credit for pollutants in the discharger's intake water if:

(i) The applicable effluent limitations and standards contained in 40 CFR subchapter N specifically provide that they shall be applied on a net basis; or

(ii) The discharger demonstrates that the control system it proposes or uses to meet applicable technology-based limitations and standards would, if properly installed and operated, meet the limitations and standards in the absence of pollutants in the intake waters.

(2) Credit for generic pollutants such as biochemical oxygen demand (BOD) or total suspended solids (TSS) should not be granted unless the permittee demonstrates that the constituents of the generic measure in the effluent are substantially similar to the constituents of the generic measure in the intake water or unless appropriate additional limits are placed on process water pollutants either at the outfall or elsewhere.

(3) Credit shall be granted only to the extent necessary to meet the applicable limitation or standard, up to a maximum value equal to the influent value. Additional monitoring may be necessary to determine eligibility for credits and compliance with permit limits.

(4) Credit shall be granted only if the discharger demonstrates that the intake water is drawn from the same body of water into which the discharge is made. The Director may waive this requirement if he finds that no environmental degradation will result.

(5) This section does not apply to the discharge of raw water clarifier sludge generated from the treatment of intake water.

(h) *Internal waste streams.* (1) When permit effluent limitations or standards imposed at the point of discharge are impractical or infeasible, effluent limitations or standards for discharges of pollutants may be imposed on internal waste streams before mixing with other waste streams or cooling water streams. In those instances, the monitoring required by §122.48 shall also be applied to the internal waste streams.

(2) Limits on internal waste streams will be imposed only when the fact sheet under §124.56 sets forth the exceptional circumstances which make such limitations necessary, such as when the final discharge point is inaccessible (for example, under 10 meters of water), the wastes at the point of discharge are so diluted as to make monitoring impracticable, or the interferences among pollutants at the point of discharge would make detection or analysis impracticable.

(i) *Disposal of pollutants into wells, into POTWs or by land application.* Permit limitations and standards shall be calculated as provided in §122.50.

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