

Long Island Sound, Connecticut

General Permit for Nitrogen Discharges

Permitting Authority Contact:

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Pollutants of Concern in Watershed:

Nitrogen and low dissolved oxygen (DO)

Pollutants Addressed in General Permit:

Total nitrogen

Permit Issued: January 1, 2002

Reissued: December 21, 2005

Permit Type:

General permit for total nitrogen that overlays existing individual permits

Permit Information:

www.ct.gov/dep/lib/dep/water/municipal_wastewater/2005nitrogengpfinal.pdf

Overview

Dissolved oxygen (DO) levels drop in Long Island Sound during the summer months because of excess nitrogen. This situation causes hypoxia, which can negatively affect the habitats supporting fish, shellfish, and other bottom-dwelling aquatic life. To address this significant water quality problem, the Connecticut Department of Environmental Protection (CTDEP) and the New York State Department of Environmental Conservation (NYSDEC) collaborated on developing a total maximum daily load (TMDL) to determine the nitrogen reductions necessary to achieve the states' respective water quality standards. Connecticut's portion of reductions under the approved TMDL requires full implementation of the state's nitrogen wasteload allocation (WLA), a 64 percent reduction (9,166 equalized pounds of nitrogen per day) by the year 2014 for 79 publicly owned treatment works (POTWs).

The Connecticut General Assembly passed legislation in 2001 that authorized developing a Nitrogen Credit Exchange Program and established a framework for achieving the nitrogen WLA using innovative approaches such as water quality trading and issuing a watershed-based general permit for nitrogen. Through the Nitrogen General Permit and the Nitrogen Credit Exchange Program, participating POTWs have successfully removed 14,921 equivalent pounds of nitrogen per day from January 2002 through the first 9 months of 2006 (CTDEP 2007).

This case study provides an overview of CTDEP's Nitrogen General Permit that, along with the state's Nitrogen Credit Exchange Program, will help 79 POTWs in Connecticut's portion of Long Island Sound achieve the TMDL-mandated WLA for nitrogen by 2014.

Permitting Background

Each summer, the bottom waters of Long Island Sound from New Haven west to Greenwich violate Connecticut's

Watershed: Long Island Sound, Connecticut		
Key Water Quality Concerns: Excessive total nitrogen leading to low dissolved oxygen and hypoxic conditions.		
Stakeholder Involvement Techniques:		
<ul style="list-style-type: none"> Series of public workshops around the state One-on-one informational meetings with communities Public notice, mailing, and a formal hearing during permit reissuance process 		
Case Study Issues of Interest		
Type of Point Sources	POTW Discharges	✓
	Industrial Process Wastewater Discharges	
	Concentrated Animal Feeding Operations	
	Municipal Separate Storm Sewer System Discharges	
	Construction Site Stormwater Discharges	
	Industrial Facility Stormwater Discharges	
Highlighted Approach(es)	Combined Sewer Overflows	
	Statewide Watershed Approach	
	Implementation of Water Quality Standards	
	Implementation of Total Maximum Daily Loads or Other Watershed Pollutant Reduction Goals	✓
	Permit Coordination/Synchronization	
	Integrated Municipal Requirements	
	Point Source – Point Source Water Quality Trading	✓
	Point Source – Nonpoint Source Water Quality Trading	
Discharger Association		
Coordinated Watershed Monitoring		

Connecticut's General Permit for Nitrogen Discharges defines *Total Nitrogen* as the total of the concentrations of ammonia nitrogen, organic nitrogen, nitrite nitrogen, and nitrate nitrogen expressed as milligrams of nitrogen per liter. Permit limits are expressed in terms of annual mass loading.

DO standard of 6.0 milligrams per liter. Nitrogen is the primary pollutant causing the low DO conditions, with the most significant loadings from sewage treatment plants. The Long Island Sound TMDL for nitrogen, developed by both Connecticut and New York, calls for an

overall reduction of 58.5 percent in total nitrogen from point and nonpoint sources in both states by the year 2014. Of that overall reduction, the TMDL process assigned reduction goals for point and nonpoint sources in Connecticut. On the basis of this process, Connecticut's POTWs received a 64 percent reduction goal. To help implement the TMDL, the Connecticut General Assembly passed Public Act No. 01-180 in June 2001. The legislation establishes the framework for the Nitrogen Credit Exchange Program and directs the Nitrogen Credit Advisory Board to administer this program. A key component of the Nitrogen Credit Exchange Program is the General Permit for Nitrogen Discharges, which limits mass loadings of total nitrogen and includes monitoring and reporting requirements for 79 POTWs in Connecticut.

Permit Strategy

The CTDEP originally issued the General Permit for Nitrogen Discharges on January 2, 2002, with an expiration date of December 31, 2006, and reissued the General Permit on December 1, 2005. The permit addresses only total nitrogen discharges from the 79 POTWs. The facilities are subject to the requirements of their individual National Pollutant Discharge Elimination System (NPDES) permits for other pollutants. Appendix 1 of the General Permit contains the annual discharge limits, expressed in pounds per day, for each applicable POTW. These limits represent the allocated end-of-pipe loading for each facility.

The General Permit and the Nitrogen Credit Exchange Program work in tandem to provide POTWs with alternatives for achieving permit compliance. The General Permit requires applicable POTWs to meet their specified annual discharge limits. If the facilities cannot meet their specified limits, they must purchase equivalent nitrogen credits. Facilities with treatment that enables them to produce less than their specified annual discharge load generate credits.

Connecticut's Clean Water Fund is a key component to the success of the General Permit and the Nitrogen Credit Exchange Program by making funds available to applicable POTWs for nitrogen removal projects. The Nitrogen Credit

Advisory Board considers project costs when calculating the cost per equivalent nitrogen credit. The availability of funds affects the planning, design, and construction schedule for nitrogen removal projects, which ultimately affects the amount of total nitrogen that the POTWs can annually remove from the sound. The Nitrogen Credit Advisory Board uses the POTWs' actual removal loads to determine the number of equivalent nitrogen credits available through the Nitrogen Credit Exchange Program. Therefore, if resources in the Clean Water Fund are limited, the POTWs might not be able to complete their nitrogen removal projects and could face challenges in meeting their annual discharge limits. As a result, CTDEP might need to occasionally adjust the TMDL schedule, which calls for POTWs to meet their respective WLAs by 2014. In fact, according to the 2005 Annual Report, when the CTDEP reissued the General Permit in 2005, it increased the POTWs' 2006 annual discharge limits to reflect the implementation pace of nitrogen removal projects that could be maintained with available funds.

Connecticut's Clean Water Fund

Connecticut's Clean Water Fund provides financial assistance to municipalities for planning, design, and construction of wastewater collection and treatment projects. Funds available through the Clean Water Fund originate from five accounts comprised of federal and state monies. The Clean Water Fund provides a combination of grants (20 percent of total project costs) and loans (80 percent of total project costs) to municipalities that implement projects at the direction of CTDEP. More information on Connecticut's Clean Water Fund is at www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654

Permit Highlights

As noted previously, Connecticut designed the General Permit and the Nitrogen Credit Exchange Program to work in tandem to reduce POTW nitrogen loadings to Long Island Sound. Without the Nitrogen Credit Exchange Program, the 79 POTWs covered under the General Permit would likely face challenges in complying with their annual discharge limits. The following subsections summarize the technical aspects and functions of the Nitrogen Credit Exchange Program and describe how the program relates to the General Permit.

Nitrogen Removal Projects

The annual discharge limits contained in Appendix 1 of the General Permit decrease each year from the assumption that the aggregate amount of nitrogen discharged by the 79 POTWs will decrease as nitrogen removal projects are completed. Facilities that perform better than their annual discharge limit contained in the General Permit because of

their nitrogen removal project are eligible to sell equalized nitrogen credits through the Nitrogen Credit Exchange Program. Facilities that cannot meet their annual discharge limits (e.g., choose to defer nitrogen removal project construction) can purchase equalized nitrogen credits through the Nitrogen Credit Exchange Program.

What is a Nitrogen Removal Project?

CTDEP has defined a nitrogen removal project as any alteration of the physical structure of a wastewater treatment facility specifically to remove nitrogen and that is financed by the Clean Water Fund (CTDEP 2006).

Equivalency Factors and Equivalent Nitrogen Credits

Credits bought and sold through the Nitrogen Credit Exchange are based on a facility's annual discharge limit; however, the annual discharge limit is an end-of-pipe limit and does not account for attenuation of total nitrogen in Long Island Sound. To ensure that all POTWs exchange equivalent credits (i.e., credits that account for attenuation) through the Nitrogen Credit Exchange Program, the CTDEP developed *equivalency factors* for each POTW. The General Permit provides each facility's equivalency factor in addition to its annual discharge limits. The equivalency factor is essentially a delivery factor that relates a facility's geographic location to its relative effect on oxygen levels in western Long Island Sound—the area that exhibits the greatest effects of excessive nitrogen loading.

Annually, the CTDEP calculates the number of equivalent nitrogen credits that a POTW has available to sell or that it must purchase. The state makes this calculation by comparing a POTW's annual mass loading of total nitrogen to its

Calculating Equivalency Factors

Accounting for attenuation of total nitrogen in Long Island Sound is essential for exchanging equivalent nitrogen credits. CTDEP and NYSDEC used modeling and monitoring information to understand attenuation factors in Long Island Sound and during riverine transport. CTDEP used these factors to quantify relationships between discharge points and the actual delivery of nitrogen to Long Island Sound. Combined, these factors account for the relative impact of nitrogen on DO depletion in Long Island Sound from geographically distributed sources. To calculate the overall equivalency factors, CTDEP multiplied the river delivery factor for a specific tier within one of Connecticut's six Long Island Sound management zones by the Long Island Sound transport efficiency from a zone once the nitrogen reached the edge of the Sound. CTDEP expresses the factors as the decimal fraction of the nitrogen load delivered (CTDEP and NYSDEC 2000).

annual discharge limit and then multiplies the difference by the facility's equivalency factor. The result is the number of equivalent nitrogen credits the POTW must purchase to remain in compliance or that it has available to sell.

CTDEP works with the Nitrogen Credit Advisory Board to set prices and administer the Nitrogen Credit Exchange each year. The board sets prices on the basis of the cost of the nitrogen removal projects implemented, the number of pounds of nitrogen removed, and the cost of operating and maintaining the facilities where projects have been implemented. CTDEP and the Nitrogen Credit Advisory Board also work cooperatively to ensure that reporting and accounting under the exchange are accurate and that bills and credits are disbursed according to the schedule set forth in the underlying state law.

Permit Components

Discharge limits

The annual discharge limits applicable to each POTW are specified in Appendix 1 to the General Permit. The Appendix is incorporated in its entirety into the General Permit at section 4(a). Appendix 1 presents a comprehensive list of each POTW by management zone. For each POTW, the Appendix lists the applicable equivalency factor and annual discharge limit in pounds per day for the years 2006 through 2010. Appendix 1 also presents each POTW's 2014 annual discharge limit to meet the nitrogen WLA.

To provide a more realistic projection of expected performance, CTDEP adjusted the annual discharge limits upward in the current General Permit (see *Permit Effectiveness*). The fact sheet for the General Permit states that CTDEP will revise the annual discharge limits during the term of the permit as new information becomes available regarding the progress of achieving the final WLA.

All POTWs remain subject to effluent limitations for all other parameters in their existing individual permits.

Monitoring and reporting requirements

Section 4(d) of the General Permit specifies the frequency for total nitrogen monitoring for POTWs on the basis of the design flow rate specified in each facility's individual permit. Under the General Permit, POTWs with a design flow rate of less than 10 million gallons per day must monitor total nitrogen weekly. POTWs with a design flow rate equal to or greater than 10 million gallons per day must monitor total nitrogen twice per week. In addition, final effluent and monitoring locations that are used to determine compliance for the individual permit are also used to determine compliance with the General Permit. The General Permit not only requires facilities to monitor total nitrogen, but also the average daily volume of effluent flow that corresponds to the daily composite samples of total nitrogen.

The General Permit provides reporting requirements in Section 4(e). Facilities must submit three types of reports to CTDEP. Facilities must provide information on total nitrogen sampling and effluent flow volume on *Monthly Operating Reports* and *Nitrogen Analysis Reports*; these two reports are fundamental to the Nitrogen Credit Exchange Program. In addition, facilities must also provide monthly mass loading of total nitrogen on *Discharge Monitoring Reports*, the standard type of report required from all NPDES permittees.

Permit Compliance

Compliance conditions are presented in Section 4, *Conditions of this General Permit*. The General Permit provides two options for achieving compliance. Under the first option, each permittee must have an annual mass loading of total nitrogen that is less than or equal to its respective annual discharge limits. Under the second option, permittees that exceed their respective annual discharge limits can achieve compliance by purchasing equivalent nitrogen credits through the Nitrogen Credit Exchange Program. The number of equivalent nitrogen credits must offset the amount of the exceedance to achieve compliance. Permittees that exceed their respective annual discharge limits and do not purchase the necessary amount of equivalent nitrogen credits are out of compliance and subject to enforcement.

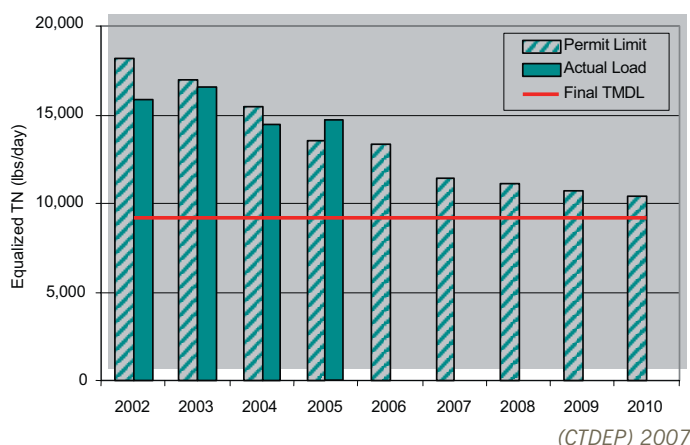
Permit Effectiveness

Each year the Nitrogen Credit Advisory Board prepares an annual report on the Nitrogen Credit Exchange Program for the Joint Standing Environmental Committee of the Connecticut General Assembly. Monitoring data contained in these reports indicate that Connecticut’s POTWs have performed

below the aggregate permit limits during the period 2002–2004. During 2005, however, the POTWs exceeded the aggregate permit limit by 1,496 equalized pounds per day. The POTWs exceeded the aggregate limit again in 2006. Table 1 below presents a summary of POTW performance in meeting the aggregate nitrogen limit from 2002 to 2006.

Figure 1, from the 2005 Annual Report, shows the overall equalized nitrogen discharged during 2002–2005, future permit limits through 2010, and the 64 percent nitrogen reduction goal to be met in 2014.

Figure 1. Annual Progress (2002-2005) and Future Limits Necessary to Meet the TMDL for Long Island Sound



The effectiveness of the General Permit in achieving annual total nitrogen discharge limits and the final WLA is partially dependent on weather conditions that affect nitrogen removal

Table 1. Summary of Nitrogen Credit Exchange Program Performance

Year (Price per credit)	Facilities selling credits	Number of equalized nitrogen credits sold (total value)	Facilities buying credits	Number of equalized nitrogen credits purchased (total cost)	Remaining credits purchased by CTDEP
2002 (\$1.65)	38	1,671,105 (\$2,757,323)	38	798,317 (\$1,317,223)	872,788 (\$1,440,100)
2003 (\$2.14)	37	1,134,876 (\$2,428,636)	40	989,194 (\$2,116,875)	145,682 (\$311,761)
2004 (\$1.90)	35	1,399,896 (\$2,659,804)	44	940,387 (\$1,786,736)	459,509 (\$873,068)
2005 (\$2.11)	28	623,408 (\$1,315,392)	50	1,169,553 (\$2,467,757)	
2006 (Jan–Sept) (\$3.40)	33	702,209 (\$2,387,510)	46	1,129,157 (\$3,839,134)	

performance. Unanticipated, adverse weather conditions, characterized by wetter and colder winter and spring conditions, hampered the performance of nitrogen removal treatment during 2003 and 2005. (Although POTWs met the aggregate permit limit for 2003, the actual load was very close to the permit limit. There was only a difference of 401 equalized pounds per day between the actual load and the permit limit.) In 2003 annual rainfall was 25 percent higher than average and occurred during the winter and spring.

Similar conditions (i.e., it was wetter and colder than average) occurred during the first half of 2005. According to the 2005 Annual Report, the cold weather affected the performance of POTWs using biological nitrogen removal technology, and excessive rainfall resulted in high infiltration rates that further affect performance. It is possible for nitrogen removal treatment to improve over the course of the remaining months in such years with warmer and dryer conditions. This was the case in 2003; the POTWs were able to stay just below the aggregate permit limit for that year. It was not the case in 2005, however. While rainfall and temperatures did improve in the second half of 2005, weather conditions were adverse in October and likely contributed to the POTWs' exceedance of the 2005 aggregate permit limit. CTDEP purports in its 2005 Annual Report that as additional facilities install nitrogen removal technology, the potential to remove greater amounts of nitrogen in all weather conditions will be achieved. Therefore, CTDEP expects to witness a long-term downward trend in loading to Long Island Sound. The Nitrogen Credit Advisory Board in its 2006 Annual Report recommended a training and technical assistance program for POTW operators to improve nitrogen removal efficiency in adverse weather conditions.

Although weather plays an important role, CTDEP also maintains that adequate funding for POTWs through the Clean Water Fund is critical for enabling the POTWs to implement nitrogen removal technologies and meet their respective annual discharge limits. CTDEP has reported that as of January 2007, five denitrification projects are ready to enter the construction phase; however, there is no Clean Water Fund financing available for these projects. CTDEP's 2006 Annual Report emphasizes the need for nitrogen removal projects to continually move into the construction phase to ensure that the state's 79 POTWs achieve the interim nitrogen compliance reduction for 2009 and the final TMDL WLAs in 2014.

Lessons Learned

Paul Stacey of the Long Island Sound Program and other CTDEP permits staff were asked a number of questions regarding *lessons learned* from the state's general permit and nutrient trading efforts. The questions asked and the responses to them are summarized below.

- ◆ What has been the most challenging part of the project?

CTDEP's Municipal Facilities Program staff experienced a few challenges associated with developing and implementing the General Permit to achieve the TMDL 2014 WLAs. During the development process of the initial General Permit, conducting the necessary outreach to garner support from the municipalities was a necessary, but challenging, aspect of the project. CTDEP conducted a series of public workshops around the state and put out an offer to communities to hold one-on-one informational meetings. During the reissuance process for the General Permit, the stakeholder involvement process was not as intensive. It consisted of a public notice, mailing, and a formal hearing. The reissuance process did not reveal any objectors to the General Permit. Limited funding for denitrification projects is also a significant challenge, particularly because of the large demand for financing through the Clean Water Fund.

- ◆ What could have been done differently to resolve the challenges more easily?

Given the importance of adequate funding, there is a need to continually educate and communicate with the state legislature on the progress of the Nitrogen Credit Exchange Program and the importance of sustainable funding for denitrification projects. The Nitrogen Credit Advisory Board could take time to work with state legislators to ensure that they are reading the annual reports and understanding the effect funding has on meeting permit limits and achieving the TMDL nitrogen reduction goals.

- ◆ Would this approach be applicable to other watersheds? What characteristics would define other candidate watersheds?

Several watershed-based permitting and water quality trading programs have analyzed the Long Island Sound Nitrogen Credit Exchange Program. In fact, Virginia largely modeled the state's newly developed watershed-based permitting legislation for watersheds in the Chesapeake Bay on the approach taken in the Long Island Sound.

- ◆ If the approach were to be applied in another area, what changes should be made?

Ownership of the program by its participants is essential. The state cannot provide 100 percent of the funds necessary for POTWs to implement denitrification projects. The state needs to get out early and educate stakeholders on the costs and benefits of the program. When state legislatures are involved in funding a program, water program officials need to continually educate legislators on the program's progress and funding needs.

Resources

CTDEP and NYSDEC (Connecticut Department of Environmental Protection and New York State Department of Environmental Conservation). 2000. *A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in the Long Island Sound*. <www.ct.gov/dep/lib/dep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf>.

CTDEP (Connecticut Department of Environmental Protection). 2006. *Report of the Nitrogen Credit Advisory Board for the Calendar Year 2005 to the Joint Standing Environmental Committee of the General Assembly*. May 19, 2006. <www.ct.gov/dep/lib/dep/water/lis_water_quality/nitrogen_control_program/2005annrpt.pdf>.

Connecticut Department of Environmental Protection (CTDEP). 2007. *2006 Report of the Nitrogen Credit Advisory Board to the Joint Standing Environmental Committee of the General Assembly*. January 3, 2007. <www.ct.gov/dep/lib/dep/water/lis_water_quality/nitrogen_control_program/2006annualreportjan07.pdf>.

Connecticut Clean Water Fund. No date. <www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654>.

Note: All Web references current as of July 6, 2007.