

Restoring the Long Island Sound While Saving Money

Lessons in Innovation and Collaboration

Total Maximum Daily Loads

TMDLs at Work

in Connecticut and New York

TMDL at a Glance

Long Island Sound Nitrogen TMDL

(approved April 2001)

www.longislandsoundstudy.net/pubs/reports/Tmdl.pdf

Factors causing impairment

Aesthetics, fishing, and water contact recreation designated uses impaired due to reduced dissolved oxygen levels and excessive algal blooms

Sources contributing to impairment

Sewage treatment plants, combined sewer overflows, agricultural runoff, urban runoff, and atmospheric deposition

Restoration options

Attain a 58.5 percent reduction in nitrogen discharges to Long Island Sound from Connecticut and New York. Upgrade sewage treatment plants with nitrogen removal technologies, implement a nitrogen credit trading program, issue bubble permits to sewage treatment plants, reduce atmospheric deposition by controlling nitrous oxide emissions from vehicles, control polluted runoff through stormwater best management practices and growth management

Stakeholder involvement

Long Island Sound Study partners, including state and federal agencies, private organizations, and educational institutions; Connecticut Department of Environmental Protection; New York State Department of Environmental Conservation; municipalities along the Sound's shore throughout New York; municipalities in Connecticut; New England Interstate Water Pollution Control Commission; U.S. Environmental Protection Agency

Status of waterbody

Nitrogen loading to Long Island Sound reduced by 25 percent from the adjusted 1990 baseline load.

Benefits to stakeholders

Reduced nitrogen loads, cost savings, funding, partnerships

Is it possible to make significant reductions in pollution while saving tax payers a large amount of money? Stakeholders in the Long Island Sound are demonstrating that it is possible, using innovative approaches and multi-state collaboration. Once referred to as the American Mediterranean for its unspoiled beauty, the nature of the Long Island Sound has dramatically changed to an urban sea due to decades of growth and development. Today the Sound's watershed is home to almost 9 million people with an area that includes most of Connecticut and portions of New York, Rhode Island, New Hampshire, Massachusetts, and Vermont. Pollutant sources associated with increased

urbanization, including sewage treatment plants and stormwater runoff, have discharged excessive levels of nitrogen to the Sound leading to increased algal blooms and decreased dissolved oxygen (DO) levels. As a result of eutrophication and hypoxia, large areas in the western portion of the Sound can not support aquatic life, recreation, and other important uses.

To address the water quality problems in the Long Island Sound, EPA created the Long Island Sound Study (LISS) in partnership with the Connecticut Department of Environmental Protection (CTDEP) and the New York State Department of Environmental Conservation (NYSDEC). The LISS focuses on research, monitoring, and modeling of the Sound to effectively address nitrogen loads, improve DO levels, and meet water quality standards. Work conducted through the LISS helped to support the development of the nitrogen TMDL for the Long Island Sound, a joint effort by the states of Connecticut and New York. Innovative implementation strategies, including a nitrogen credit trading program for sewage treatment plants (STPs) in Connecticut and bubble permits for STPs in New York, have not only led to significant nitrogen reductions in Long Island Sound, but also significant cost savings.

How are TMDLs at work in Long Island Sound?

Years of research, monitoring, and modeling helped the LISS to identify nitrogen sources in the Long Island Sound and levels of nitrogen control necessary to improve DO levels and meet water quality standards. The analysis conducted by the LISS led to the adoption of a 58.5 percent nitrogen reduction target to reduce the extent and duration of hypoxic conditions in the Long Island Sound. Through the TMDL development process, CTDEP and NYSDEC were able to incorporate the 58.5 percent nitrogen reduction target into a regulatory and legal framework.

The Clean Water Act (CWA) requires implementation of pollutant load reductions through point source permits issued under the National Pollutant Discharge Elimination System (NPDES) Program. As a result, CTDEP and NYSDEC point source permit writers must develop permit requirements to implement the

What is a total maximum daily load (TMDL)?

It is a study or analysis that calculates the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The TMDL establishes a pollutant budget and then allocates portions of the overall budget to the pollutant's sources. For more information on TMDLs, visit EPA's website at www.epa.gov/owow/tmdl.



Figure 1. Stratford aeration tank.

nitrogen reduction target. Without the TMDL, the nutrient reduction target established by the LISS after years of research and analysis would not have an enforceable implementation mechanism. In addition, the nitrogen TMDL for the Long Island Sound recommends flexible, innovative implementation approaches, including nitrogen trading.

Who were the participating stakeholders and key partners?

Development of TMDLs in the states of Connecticut and New York is the responsibility of the CTDEP and the NYSDEC. To develop the nitrogen TMDL for Long Island Sound, CTDEP and NYSDEC worked through the LISS—a partnership of federal, state, local government agencies, private organizations, and educational institutions. TMDL implementation, unlike TMDL development, is largely in the hands of stakeholders and partners that can play a role in achieving pollutant load reductions, depending on the actions recommended by the TMDL. In the case of the Long Island Sound, a significant

portion of implementation activities have focused on upgrades to STPs in Connecticut and New York to achieve nitrogen reductions. Figure 1 shows an aeration tank installed at the Stratford (Connecticut) STP as part of the facility's upgrade to implement a biological nutrient removal technique. Other LISS partners also provide funding for research and implementation projects to address the hypoxia problem.

How did stakeholders participate in the TMDL process?

The overall TMDL process includes the following elements: CWA section 303(d) listing decisions, TMDL development, and TMDL implementation. Each element of the TMDL process provided stakeholders with an opportunity to express concerns and share information about the water quality problems in the Long Island Sound with CTDEP, NYSDEC, and other LISS partners. A description of each element of the TMDL process is provided below.

Section 303(d) listing decisions

If a waterbody does not meet water quality standards for one or more pollutants, it goes on a state's 303(d) list. Impaired waterbodies on this list require a TMDL for each pollutant contributing to the impairment. Stakeholders have the opportunity to provide input during the 303(d) listing process. Extensive public involvement in the LISS in the late 1980s and early 1990s provided stakeholder input into conditions in the Sound and in identifying use impairments. Both CTDEP and NYSDEC placed the Long Island Sound on their state's 303(d) list in 1992 due to low DO levels. According to the final TMDL report, the low DO levels in the Sound led to impairments in bathing area quality, an increase in unhealthy areas for aquatic marine life, an increase in mortality of sensitive organisms, poor water clarity for scuba divers, a reduction in commercial and sport fisheries values, a reduction in wildlife habitat value, degradation of seagrass beds, impacts on tourism and real estate, and poorer aesthetics.

TMDL development

Established in 1985, the LISS conducted much of the research, monitoring, and computer modeling of the Long Island Sound necessary for developing a TMDL to address low DO. Years of research and monitoring helped the LISS to create a three-dimensional, time variable, hydrodynamic and water quality model called the LIS 3.0 model. Using

this model, the LISS analyzed the relationship among factors affecting DO levels and demonstrated that nitrogen is the primary pollutant causing water quality impairments.

The LISS developed and, in 1998, adopted a plan entitled *Phase III Actions for Hypoxia Management* that recommended nitrogen reduction targets. The analysis conducted for this plan focuses on identifying the sources of nitrogen in the Long Island Sound, calculating the nitrogen load associated with these sources, and setting a numeric target for reducing nitrogen to achieve Connecticut and New York's DO water quality standards. The LISS identified municipal and industrial wastewater treatment facilities, combined sewer overflows (CSOs), urban and agricultural runoff, and atmospheric deposition as significant sources of nitrogen to the Sound. To identify nitrogen loads from these sources, the LISS examined in-basin loads from 12 management zones and loads from tributaries north of Connecticut. The analysis estimated that a total of 100,436 tons per year of nitrogen reached the Long Island Sound from both in-basin and tributary sources, with 42 percent of that total load from municipal and industrial wastewater treatment facilities. Of the total nitrogen load, approximately 53 percent originates from in-basin sources, with in-basin point sources contributing 73 percent of the nitrogen load. Additional analysis demonstrated that the current limit of technology on these sources in Connecticut and New York would not fully achieve water quality standards. To improve DO levels to meet water quality standards, the analysis showed that tributary nitrogen reductions and management alternatives in addition to nitrogen removal would be necessary.

The TMDL development process integrated the analysis conducted to develop the *Phase III Actions for Hypoxia Management* plan and used the 58.5 percent nitrogen reduction target for in-basin sources as a basis for establishing a nitrogen budget among sources. In addition, the final TMDL report identifies additional actions and schedules from sources outside the basin and non-treatment alternatives necessary to achieve water quality standards. The final TMDL report provides the nitrogen wasteload allocations (WLAs) assigned to point sources, as well as the load allocations (LAs) assigned to nonpoint sources, within each of the 12 management zones. The final TMDL report states that point sources within a management zone have the opportunity to reallocate WLAs with each other. Point sources in different management zones can also reallocate WLAs with each other using an equivalency factor to account for nitrogen loss and impact on DO levels in the Sound.

The final TMDL report states that addressing the tributary nitrogen sources located outside of Connecticut and New York will require EPA to take the lead. The TMDL analysis estimated that retrofit upgrades to STPs outside of the basin could reduce nitrogen loads from these sources by 25 percent and nonpoint source runoff controls could reduce nitrogen loads by 10 percent. In addition, Clean Air Act implementation could reduce basinwide atmospheric nitrogen loads by 18 percent.

Developing the *Phase III Actions for Hypoxia Management* plan and the Long Island Sound nitrogen TMDL included involving the public. For the Phase III plan, the LISS mailed 4,000 copies of the plan to a wide range of stakeholders and conducted a series of 12 public meetings in Connecticut and New York. For the TMDL, CTDEP and NYSDEC also mailed copies of the draft TMDL report to stakeholders and held a series of public meetings. Through the formal public comment period, CTDEP and NYSDEC received 33 comment letters. In addition, CTDEP conducted a separate public involvement process for the point sources assigned individual WLAs under the TMDL. This process, which was intended to refine the Connecticut point source WLAs, resulted in six public meetings attended by 120 participants as well as the submittal of 24 comment letters. The final TMDL report reflected input provided by stakeholders on a variety of technical issues.

TMDL implementation

Implementing the nitrogen TMDL for the Long Island Sound involves a five-phase, iterative approach focused on action, assessment, and adjustment referred to as adaptive management. Phases I, II, and III were precursors to the TMDL, developed by the LISS as part of the Comprehensive Conservation and Management Plan initiated in 1988.

The LISS Phase I program placed a freeze on point and nonpoint nitrogen sources at 1990 levels to protect the Sound from further nitrogen pollution; the 1990 nitrogen levels served as a baseline for the TMDL. The Phase II action plan went into effect in 1994 and focused on implementing low-cost retrofits at selected STPs to reduce nitrogen loads. The Phase III action plan, which provided the basis for the 58.5 percent nitrogen reduction target in the TMDL, included a 15 year implementation schedule with three five-year incremental targets. The Phase III action plan implementation schedule started in August 1999 and ends in August 2014. Actions under this phase focus on revisions to NPDES permits for point sources and development of nonpoint source management plans. The ability to reallocate nitrogen reductions among point sources, commonly referred to as nitrogen trading, is a central component of the Phase III implementation activities.

Both Connecticut and New York have approaches in place to help point sources reallocate their nitrogen WLAs under the TMDL. To facilitate nitrogen load reallocations, Connecticut developed and issued a nitrogen general permit and created a Nitrogen Credit Trading Program for the 79 STPs located throughout the state. New York devised a *bubble permit* strategy to allow for flexibility in the upgrade construction scheduling for STPs within the management zones established by the TMDL. This strategy provides STPs with the flexibility to determine how best to meet the overall nitrogen WLA applicable to a management zone. However, if the group of STPs exceeds a WLA for a management zone, STPs are subject to the individual WLAs, as published in the TMDL, for the purpose of compliance. The New York City (NYC) plants and permits are somewhat different in that NYC has elected to meet all of the NYC-owned STP WLAs for zones 8 & 9 with upgrades to only the STPs in Zone 8. Connecticut's program is expected to save between \$200 and \$400 million in wastewater treatment construction costs over the next ten years and New York's bubble permits are expected to save money as well. For example, New York City is expected to save \$660 million in STP upgrade costs.

The LISS publishes an annual implementation tracking report that includes activities related to achieving the 58.5 percent nitrogen reduction target in the TMDL. According to the 2007 report, between 2003 and 2007 Connecticut and New York reduced nitrogen loads from point sources by 9,700 trade equalized (TE) pounds per day (lbs/day). The TMDL baseline load is 59,146 TE lbs/day, with 39,700 TE lbs/day discharged by 106 treatment plants as of December 2007. The 2014 TMDL goal is 22,774 TE lbs/day.

Phase IV actions focus on achieving nitrogen reductions from sources located in states north of Connecticut. Implementation actions under this phase will focus on developing a nitrogen reduction program for upstream areas and implementing existing Clean Air Act programs to reduce out-of-basin nitrogen loads to achieve the applicable DO water quality standards. The New England Interstate Water Pollution Control Commission (NEIWPCC) is assisting in TMDL implementation efforts by coordinating the effort to better define nitrogen sources and loads in the Upper Connecticut River Basin. This effort involves Connecticut, Massachusetts, New Hampshire, Vermont, and U.S. EPA.

Phase V actions include the review, evaluation, and implementation, as needed, of non-treatment alternatives. The LIS will identify specific actions in a revised TMDL, planned after the five-year evaluation under the Phase III implementation schedule, after considering all in-basin and out-of-basin air and water controls.

Under an adaptive management approach, the LISS has identified several opportunities for reassessment and revision of the TMDL. The TMDL is currently undergoing revision as part of the adaptive management approach.

What is the current status of the Long Island Sound as a result of the TMDL process?

To track the health of the Long Island Sound over time, the LISS uses a suite of environmental indicators based on recent chemical, biological, and physical data. The focus of the nitrogen TMDL is to reduce nitrogen loads as a way to increase the levels of DO in the Sound. Increased DO levels should decrease the number of days and the extent of hypoxia in the Sound during the critical summer months. Because hypoxia is related to both physical conditions and nutrient loadings, weather patterns affect the severity of hypoxia that occurs from year to year. As a result, long term monitoring is needed to identify trends over time. According to the LISS environmental indicators, the extent of hypoxic conditions during 2007 was 162 square miles; the seventh least severe year since 1991. Hypoxia in the bottom waters lasted 58 days, one day above the average from 1987 through 2007. As discussed in the final TMDL report, attaining the DO water quality standards will require further nitrogen reductions from both in-basin and out-of-basin sources.

How did local stakeholders benefit from the TMDL process?

Implementing innovative nitrogen reduction approaches, including nitrogen credit trading and nitrogen load reallocation under bubble permits, has helped point sources in Connecticut and New York make significant progress toward achieving the 58.5 percent nitrogen reduction goal for 2014. It is anticipated that these improvements, coupled with nitrogen reductions from out-of-basin sources, will improve DO levels and reduce hypoxic conditions in the Long Island Sound over time.

In addition to water quality benefits, the TMDL process and the innovative approaches for achieving nitrogen load reductions promoted through the TMDL have benefitted stakeholders in several ways.

- **Increased cost savings while achieving nitrogen reductions.** Upgrading STPs is an expensive endeavor. During 2003–2007, Connecticut has upgraded 19 STPs for a cost of \$56.5 million. However, through Connecticut’s Nitrogen Credit Exchange Program, the upgrades generated \$10.5 million worth of nitrogen credits in five years. This program is expected to save between \$200 and \$400 million in wastewater treatment construction costs over the next ten years. New York’s bubble permits for management zones are expected to save money as well. For example, New York City is expected to save \$660 million in STP upgrade costs.
- **Improved water quality for recreation activities important to the regional economy.** Based on a 1992 study, recreational activities in the Long Island Sound are estimated to contribute an annual revenue of more than \$8 billion (inflation adjusted) to the regional economy. As water quality improves, tourists are more likely to use the Long Island for swimming and boating, generating more cash flow.
- **Increased recognition for innovative approaches.** The innovative approaches at work in the Long Island Sound are the topic of many presentations, journal articles, and case studies. In 2007, Connecticut’s Nitrogen Credit Exchange received EPA’s Blue Ribbon Water Quality Trading Award for the program’s outstanding accomplishments.

- **Increased access to funding.** LISS partner agencies and organizations contribute funding to support implementation activities that will achieve nutrient reductions and achieve DO water quality standards in the Sound. Connecticut has provided hundreds of millions of dollars in grants and loans through its Clean Water Fund to implement nitrogen reductions. New York targeted \$270 million in grant assistance for Long Island Sound in the 1996 Clean Air/Clean Water Bond Act.
- **Increased local, state, and regional partnerships.** The LISS is a highly effective bi-state partnership that involves state and federal agencies, concerned organizations, and individuals. Through the TMDL process, the network of partnerships has grown. Individual STPs collaborate with the states and other STPs to achieve nitrogen load reductions. States north of Connecticut collaborate to establish out-of-basin nitrogen reduction targets and identify strategies to achieve those targets. The public participation processes for the TMDL process and the subsequent permitting activities also generate partnerships within the Long Island Sound watershed.



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For more information on the Connecticut TMDL Program,
visit www.ct.gov/dep/cwp/view.asp?a=2719&q=325604&depNav_GID=1654

For more information on the New York TMDL Program, visit www.dec.ny.gov/chemical/31290.html