Watershed Synthesis Section

A Preliminary and Qualitative Evaluation of the Adequacy of Current Stormwater and Nonpoint Source Nitrogen Control Efforts in Achieving the 2000 Long Island Sound Total Maximum Daily Load for Dissolved Oxygen

Watershed Synthesis Section completed by NEIWPCC on behalf of the Five-State/EPA/NEIWPCC Long Island Sound TMDL Workgroup. The work was performed under the *Enhanced Implementation Plan for the Long Island Sound Total Maximum Daily Load*, an agreement signed by the five Long Island Sound watershed states and U.S. EPA Regions 1 and 2.

Finalized August 2014

Abstract

Coordinated by the New England Interstate Water Pollution Control Commission (NEIWPCC), the Long Island Sound (LIS) Total Maximum Daily Load (TMDL) Workgroup consists of representatives from the Sound's five watershed states including staff from the Connecticut Department of Energy and Environmental Protection (CTDEEP), Massachusetts Department of Environmental Protection (MassDEP), New Hampshire Department of Environmental Services (NHDES), New York State Department of Environmental Conservation (NYSDEC), and Vermont Department of Environmental Conservation (VTDEC). The workgroup also includes U.S. Environmental Protection Agency representatives from EPA's Region 1 and Region 2 offices, its Long Island Sound Office (LISO), and the agency's Office of Research and Development (ORD).

In 2012, the Long Island Sound Study (LISS) Management Committee and the five watershed states approved a framework for the assessment of the TMDL known as the Enhanced Implementation Plan. This report on the adequacy of current stormwater and nonpoint source nitrogen control efforts in achieving the 2000 LIS TMDL for dissolved oxygen is one component of that plan. The report consists of five state sections written by CTDEEP, MassDEP, NHDES, NYSDEC, and VTDEC and a watershed synthesis section completed by NEIWPCC in partnership with LISS. This watershed section of the report serves as a synthesis and evaluation of TMDL-related implementation efforts at the state and watershed level.

Acknowledgments

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NEIWPCC wishes to thank the many individuals of the LIS TMDL Workgroup and others who assisted in the preparation of this report by providing data, images, pictures, or by acting as reviewers.

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This project was funded by an agreement awarded by the United States Environmental Protection Agency to the New England Interstate Water Pollution Control Commission in partnership with the Long Island Sound Study.

Although the information in this document was developed under Cooperative Agreement LI-97188201 awarded by the U.S. Environmental Protection Agency, it has not undergone the Agency's publications review process and therefore, may not necessarily reflect the views of the Agency and no official endorsement should be inferred.

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Acronyms

Agricultural Environmental Management	AEM
Farm Well Water Testing	FWWT
Accepted Agricultural Practices Assistance	AAPA
Agricultural Management Assistance	AMA
Agricultural Resource Specialist Program	ARS
Alteration of Terrain	AoT
Alternative Manure Management Program	AMM
Ammonium	NH_4
Best Management Practice	BMP
Center for Land Use Education and Research	CLEAR
Clean Air Act	CAA
Clean Air Interstate Rule	CAIR
Clean Air Status and Trends Network	CASTNET
Clean Air Act Amendments	CAAA
Combined Sewer Overflow	CSO
Comprehensive Conservation and Management Plan	CCMP
Concentrated Animal Feeding Operations	CAFO
Connecticut Department of Energy and Environmental Protection	CTDEEP
Conservation Reserve Enhancement Program	CREP
Conservation Reserve Program	CRP
Conservation Stewardship Program	CSP
Construction General Permit	CGP
Dissolved Oxygen	DO
Electricity Generating Unit	EGU
Enhanced Implementation Plan	EIP
Environmental Quality Incentives Program	EQIP
Farm Agronomic Practices	FAP
Farm and Ranch Lands Protection Program	FRPP
Farmland Access Program	FAP
Farmland Preservation Program	FPP
Geographic Information System	GIS
Grassland Reserve Program	GRP
Illicit Discharge Detection and Elimination	IDDE
Land Treatment Planners	LTP
Load Allocation	LA
Long Island Sound	LIS
Long Island Sound Futures Fund	LISFF
Long Island Sound Study	LISS
Low Impact Development	LID
Massachusetts Department of Agricultural Resources	MDAR

Massachusetts Department of Environmental Protection	MassDEP
Minimum Control Measures	MCM
Multi-Sector General Permit	MSGP
Municipal Separate Storm Sewer System	MS4
National Ambient Air Quality Standards	NAAQS
National Atmospheric Deposition Program	NADP
National Land Cover Database	NLCD
National Pollutant Discharge Detection and Elimination System	NPDES
National Trends Network	NTN
Natural Resources Conservation Service	NRCS
New Hampshire Department of Transportation	NHDOT
New Hampshire Department of Agriculture	NHDA
New Hampshire Department of Environmental Services	NHDES
New York State Department of Environmental Conservation	NYSDEC
Nitrate	NO_3
Nitrogen Oxide	NOx
Nutrient Management Incentive Grant Program	NMPIG
Ozone Transport Region	OTR
Partners for Fish and Wildlife Habitat Restoration Program	PFW
Reasonably Available Control Technology	RACT
Regional Acid Deposition Model	RADM
Shoreland Water Quality Protection Act	SWQPA
State Pollutant Discharge Detection and Elimination System	SPDES
Stormwater Pollution Prevention Plans	SWPPP
System-Wide Eutrophication Model	SWEM
Technical Assistance Programs	TAP
Total Kjeldahl Nitrogen	TKN
Total Maximum Daily Load	TMDL
United States Department of Agriculture	USDA
United States Environmental Protection Agency	EPA
United States Geological Survey	USGS
University of New Hampshire Storm Center	UNHSC
Vermont Agency of Agriculture, Food and Markets	VT AAFM
Vermont Agricultural Buffer Program	VABP
Vermont Department of Environmental Conservation	VTDEC
Vermont Department of Transportation	VTrans
Wasteload Allocation	WLA
Wastewater Treatment Plant	WWTP
Water Quality Certifications	WQC
Water Quality Standards	WQS
Wetlands Reserve Program	WRP
Wildlife Habitat Incentive Program	WHIP

Executive Summary

Hypoxia, or low dissolved oxygen (DO), has been identified as the issue of greatest concern in Long Island Sound (LIS), and excess nitrogen loading to the Sound is a primary cause of the problem. To address the excess nitrogen, and resulting DO problems, the Connecticut Department of Energy and Environmental Protection (CTDEEP) and New York State Department of Environmental Conservation (NYSDEC) developed a Total Maximum Daily Load (TMDL) for Dissolved Oxygen. The TMDL, which EPA approved in 2001, outlined nitrogen reductions necessary to meet water quality standards in the Sound by 2014. These reductions include a 58.5% reduction in nitrogen loading from sources in CT and NY, a 25% reduction from point sources and a 10% reduction in nonpoint sources in the upper basin states (MA, NH, VT), and an 18% reduction in nitrogen from atmospheric deposition.

The TMDL has a phased implementation plan, which includes commitments to reevaluate nitrogen reduction targets periodically and prepare revised TMDLs accordingly. The TMDL reevaluation process is underway, and may result in updated nitrogen allocations for both in-basin sources (CT, NY) and out-of-basin sources (MA, NH, VT, the New York Harbor, the Race, and the Atlantic Ocean). To guide this effort, the Long Island Sound Study (LISS) Management Committee and the five watershed states (CT, MA, NH, NY, and VT) approved in 2012 a framework for TMDL assessment known as the Enhanced Implementation Plan. This report represents one component of the plan: a qualitative evaluation of the adequacy of TMDL implementation, since the 1990 TMDL baseline, in attaining TMDL load allocations (LAs) for nitrogen loading from regulated stormwater and nonpoint sources associated with developed lands, agricultural lands, and atmospheric deposition. Findings of this report are summarized as follows.

Land cover and land use data indicate that the watershed has undergone additional development since 1990. According to the National Land Cover Database (NLCD), developed land cover increased by 0.20% (26,808 acres) and impervious cover increased by 0.06% (8,093 acres) from 2001 to 2006. At the same time, forested land cover decreased by 0.40% (41,320 acres) and total agricultural land (cultivated crops and hay/pasture) decreased by 0.04% (4,557 acres). Center for Land Use Education & Research (CLEAR) data for CT and NY show developed land cover increased by 2.90% (109,205 acres) and impervious cover increased by 0.80% (28,630 acres) in the states' portion of the watershed from 1985 to 2010. According to the U.S. Census Bureau, population in the watershed grew by 7.92% (402,065 persons) and population density increased by 8.42% (28 persons per square mile) from 1990 to 2010. These data indicate watershed-wide development, but the greatest degree of development is occurring in the expansion of the many urban centers in the lower watershed. Development is a driver for increases in nitrogen loading from stormwater, nonpoint source runoff, and wastewater.

Although development tends to increase nitrogen loading, the effect is expected to be mitigated by a number of nitrogen management programs that have been initiated or expanded since 1990. For example, NH's Alteration of Terrain permit program (established in 1981, expanded in 2009) addresses the impact of development or redevelopment on water quality (including nitrogen reduction benefits). NH reports 422 permanent BMPs have been put in place since 2004 under the Alteration of Terrain Permit. MA's Wetland Act and Regulation (established in 1996, expanded in 2008) includes stormwater requirements to mitigate the impact of new development and redevelopment on wetland resources and buffer zones. VT's operational or post-construction state stormwater rule (established in 1997, expanded in 2006) requires permit coverage and implementation of a stormwater management system for new or expanded impervious surfaces. Currently, 1,307 acres of impervious surface are under an active post-construction permit in the VT portion of the watershed. CT is working to minimize nitrogen loading from septic systems by addressing known problems in un-sewered areas and conducting research to inform regulation of new septic systems. In NY, the "Keep New York City Beautiful" program ticketed 1,800 dog walkers for not cleaning up pet waste, planted 1 million trees, and constructed 312 so-called "Greenstreets" in 2011.

Regulation of stormwater has also increased significantly in the LIS watershed since 1990 under the National Pollutant Discharge Elimination System (NPDES) Stormwater Program. The program regulates stormwater associated with Municipal Separate Storm Sewer Systems (MS4s) and construction, industrial, and commercial activities. EPA initiated the MS4 permit program in 1990 for large and medium communities (Phase I), which covered two cities within the LIS watershed (New York City and Stamford, CT), and expanded the program a decade later to cover small communities (Phase II). There are 84 MS4 permittees in NY, 113 in CT, and 38 in MA. (There are no MS4 permittees in the NH and VT portions of the watershed.) This means that 100% of the NY portion of the watershed, 67% of the CT portion of the watershed, and 34% of the MA portion of the watershed are under MS4 permit coverage and required to implement minimum control measures to mitigate the impact of stormwater pollution. The NPDES permits for construction, industrial, and commercial activities require registration, development of stormwater management plans, and reporting; additionally some permits require monitoring and/or visual inspections. Most of these permit programs were initiated in 1992 or 1995 and have since been revised with additional requirements.

In an attempt to measure the effectiveness of stormwater programs, the Massachusetts Department of Environmental Protection (MassDEP) conducted a BMP survey of communities in the MA portion of the watershed. MS4 communities reported on the implementation of 313 BMPs, whereas non-MS4 communities reported 86 BMPs. These numbers alone speak to the effectiveness of the MS4 permit: MS4 permitted communities are more likely to implement BMPs than non-MS4 communities. Further, MassDEP estimated that these BMPs remove approximately three times the 10% nitrogen reduction required by the TMDL LA, although this is not necessarily relative to the TMDL baseline. Also, data collected as a CT NPDES Industrial Permit monitoring and reporting requirement since 1996 and analyzed by CTDEEP estimate a 50% reduction in nitrate and 29% reduction in total Kjeldahl nitrogen when stormwater contains high concentrations of nitrogen. Finally, NYSDEC anticipates, although it is yet to be verified, implementation of the six minimum control measures (MCM) for MS4 permits can conservatively achieve a 10% reduction in nitrogen from regulated stormwater.

Although the number, diversity, and coverage of nitrogen control programs have increased since 1990, little quantitative data and information are available to measure the effectiveness of developed lands programs in reducing total nitrogen loading to LIS. The watershed itself has also undergone significant development since 1990 according to land cover and population change data. It is uncertain if the increase in scope of nitrogen management is effectively mitigating the impacts of development on nitrogen loading or if the increase in development is overriding the effectiveness of nitrogen management in achieving TMDL LAs.

Not surprisingly, given the growth seen in development, agricultural land cover and land use data indicate a decrease in the watershed's agricultural sector since 1990. According to the National Land Cover Database (NLCD), agricultural land cover classified as hay and pasture decreased by 0.01% (1,392 acres) and land cover classified as cultivated crops decreased by 0.03% (3,165 acres) from 2001 to 2006. CLEAR data show that agricultural field cover decreased by 1.10% (41,233 acres) in CT and NY (in-basin) from 1985 to 2010. A MassDEP GIS interpretation of land cover change estimates that agricultural land cover in the MA portion of the watershed decreased by 29% (59,456 acres) from 1985 to 2005. USDA Census of Agriculture data summarized by CT and VT from 1987 to 2007 and NH from 1992 to 2007 also suggest a decline in agricultural land cover and changes in agricultural land use practices. Commercial fertilizer spread decreased by 38% in CT and by 32% in VT from 1987 to 2007 and by 25% in NH from 1992 to 2007. Manure spread decreased by 25% in NH and by 10% in VT from 2002 to 2007. Farm acreage decreased by 8% (31,513 acres) in VT from 1987 to 2007 and although it increased by 28% (30,128 acres) in NH from 1992 to 2007, 89.5% (26,976 acres) of the increase in farm acreage in NH is classified as woodland. Cropland decreased by 25% (40,767 acres) in VT from 1987 to 2007 and by 7% (2,752 acres) in NH from 1992 to 2007. The total reported livestock animal population also exhibited a decline. Cattle populations decreased by 44% (60,263 cows) in CT and by 23% (15,421 cows) in VT from 1987 to 2007 and by 21% (3,057 cows) in NH from 1992 to 2007. Swine populations decreased by 33% (1,784 swine) in CT and by 34% (664 swine) in VT from 1987 to 2007 and by 23% (146 swine) in NH from 1992 to 2007. These data indicate a decline in the agricultural sector and changes in agricultural land use practices watershed-wide that would likely decrease nitrogen loading stressors from agricultural activities. At the same time, the scope of federal and state agricultural control programs that work to mitigate nitrogen loading has increased significantly since 1990.

The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) has supported the implementation of a number of agricultural BMPs in the LIS watershed. In CT, from 2004 to 2011, NRCS implemented 24,332 acres of erosion and control practices, 25,630 acres of nonpoint source practices, and 9,728 acres of nutrient management practices. In MA, from 2008 to 2011, NRCS implemented 2,225 BMPs over 20,334 acres. In NH, from 2003 to 2011, implemented NRCS BMPs include 33 waste storage facilities, five compost facilities, 89 acres of conservation cover, 2,025 acres of cover crop, 50 acres of field border, two acres of riparian herbaceous cover, 48 acres of riparian forest buffer, and 1,519 acres of prescribed grazing. In VT, at the state and federal level (including NRCS assistance), 20 of the current 21 agricultural programs that have been put in place to address water quality improvements were initiated since 1990. From 1997 to 2013, the Vermont Agency of Agriculture Food and Markets' BMP and Farm Agronomic Practices (FAP) Programs have supported implementation of 291 BMPs with $5.6 million in funding provided. Since 1990, CTDEEP has approved 269 Nutrient Management Plans for manure and wastewater management. In MA, the state's Department of Agricultural Resources (MDAR) provides education and outreach to support the NRCS Environmental Quality Incentives Program (EQIP) program, resulting in 20 BMP projects over 4,625 acres since 2009. From 2002 to 2012, NH awarded 69 grants totaling $156,862 to agricultural land and livestock owners in addition to technical assistance and public education/outreach to mitigate and prevent nutrient pollution from commercial fertilizers, manure, and agricultural composts from adversely impacting surface waters. With the relative decrease in the agricultural sector and relative increase in agricultural nitrogen management, it is likely that nitrogen loading from agricultural sources to the Sound has decreased since 1990.

The TMDL's original baseline estimates that 40.8% of the nonpoint source and regulated stormwater load originate from atmospheric deposition. A substantial portion of the anthropogenic atmospheric nitrogen deposition originates from emissions upwind of the watershed. Like land cover changes, atmospheric deposition is a factor largely outside the control of watershed management. But changes in atmospheric nitrogen deposition influence attainment of the TMDL's overall nitrogen load reduction goals. The original TMDL states that an 18% reduction in atmospheric deposition of nitrogen is anticipated from implementation of the Clean Air Act Amendments (CAAAs) of 1990, which would reduce nitrogen loads to the Sound by 1,524 tons per year. The TMDL document also states that more aggressive atmospheric nitrogen management, garnering a reduction approaching 50%, could reduce nitrogen loads to the Sound by another 2,700 tons per year. The CAAAs have contributed to making significant progress in controlling atmospheric nitrogen emissions.

The National Atmospheric Deposition Program (NADP) data collected from National Trends Network monitoring sites within or near the LIS watershed show changes in atmospheric deposition for nitrate (NO_3) and ammonium (NH_4) from 1990 to 2012. While NH_4 shows no significant changes, data show a 50% steady decrease in NO_3 in both wet deposition and precipitation-weighted mean concentrations from 1990 to 2012. EPA's Clean Air Status and Trends Network (CASTNET) reports a 26% decrease in total nitrogen deposition (wet and dry; NO_3 and NH_4) from 1990 to 2011. If these atmospheric deposition data are representative of the LIS watershed, it is likely that reductions in atmospheric deposition of nitrogen have surpassed the 18% reduction anticipated in the TMDL. However, variations in precipitation influence the rate of *wet* deposition despite overall total nitrogen deposition reductions, and wet deposition in New England makes up more than 75% of its total nitrogen deposition. Therefore it can be expected that variations in precipitation greatly influence total nitrogen deposition in the LIS watershed. For example, in 2010 and 2011, total nitrogen deposition increased at the CASTNET eastern reference sites by 33% in correlation with the highest average annual rainfall rate during the 1990 to 2011 study period.

Trend analyses of nitrogen loading based on ambient monitoring of the watershed's tributaries to Long Island Sound also suggest that nitrogen loading is influenced by precipitation. A nitrogen trend analysis shows an overall decrease in nitrogen delivered to the Sound since 1974; however, these trends have stabilized since 1999 despite significant decreases in nitrogen loading from WWTPs (46% in CT and 22% in NY since 1995 based on 2011 data). The preliminary findings of another nitrogen trend analysis conducted by USGS found that nitrogen loading has increased in some tributaries since 2000. This increase is thought to be the result of increased precipitation and in-stream flow. Furthermore, a Suffolk County Department of Health Services (2010) draft report estimates a 40% to 200% increase in nitrates (depending on depth) in the Magothy aquifer from 1987 to 2005. Evaluating the success of TMDL implementation specifically for nonpoint and stormwater sources based on existing nitrogen trend analyses is limited. Expanded monitoring and additional nitrogen trend analyses could better identify where in the watershed more action is needed.

The final outcomes for measuring success of TMDL implementation are improved water quality conditions and ultimately attainment of water quality standards. The LISS-supported CTDEEP water quality monitoring program has conducted ship-based surveys of LIS since 1991. The monthly surveys include 48 stations and are supplemented with biweekly hypoxia surveys during the summer. In recent years, a complementary, buoy-based program conducted by the University of Connecticut has collected time-series measurements at stations along the main stem of the Sound. These programs have greatly increased understanding of the variability and causal factors in the annual occurrence of hypoxia. However, since there is no significant trend in hypoxic conditions over the past two decades (due to the degree of natural variability in daily, seasonal, and annual conditions), it is premature to assess the degree to which LIS is responding to the nitrogen reductions achieved to date. Furthermore, nitrogen removal upgrades at sewage treatment plants are still coming online and the actual nitrogen removal benefits of these upgrades on DO in the Sound will not be fully realized until 2017 or later. Other factors, including predicted delays in system response to nutrient reductions and the possible influence of increasing water temperatures, also need to be taken into account.

To better inform management decision making and achieve water quality standards in the Sound, the following require further investigation:

1. Nitrogen load trends across the watershed (including the upper basin) with consideration of the impact of land cover changes and the influence of precipitation on nitrogen load delivered to the Sound.

2. Effectiveness of on-the-ground nonpoint source and stormwater nitrogen management and mitigation programs and practices.

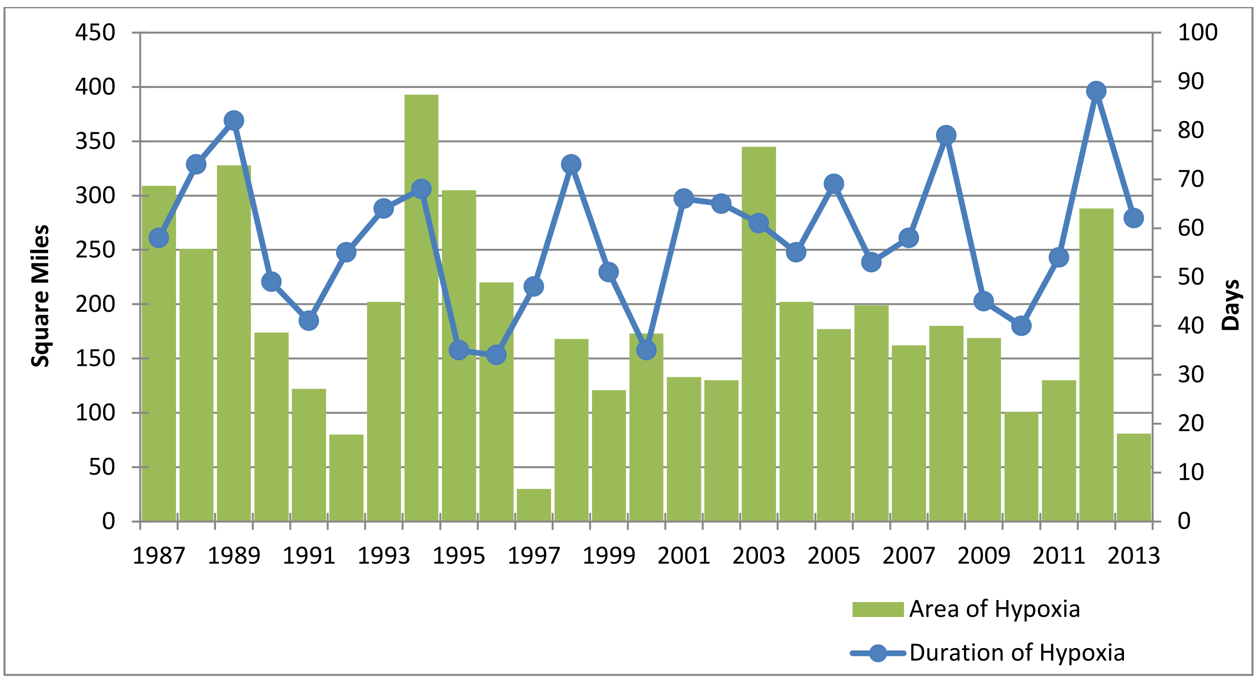
In addressing these data and information gaps, management may become better equipped to anticipate and mitigate external factors that drive nitrogen loading, and to more effectively prioritize and target nonpoint source and stormwater nitrogen control efforts in order to strengthen TMDL implementation and achieve water quality standards for DO in the Sound.

Background

The Problem

Since 1987, the Long Island Sound Study (LISS) has conducted research, monitoring, and modeling to better understand the driving mechanisms and occurrence of low dissolved oxygen (DO), also known as hypoxia, in Long Island Sound (LIS). Excess nitrogen loading to the Sound is known to be a primary cause of the hypoxia, which has long been identified as the Sound's most pressing problem. As shown in Figure 1, continued water quality monitoring over the past 26 years (1987-2013) shows that hypoxic conditions (DO < 3.0 mg/L) affect an average area of 192 square miles of bottom waters for an average period of 58 days during summer (Welsh, 1990 and Connecticut Department of Energy and Environmental Protection (CTDEEP), 2013). An additional water quality measure, the chronic criterion (DO levels below 4.8 mg/L), is also used to assess the growth and protection of aquatic life. From 1991 to 2013 DO concentrations below 4.8 mg/L affected an average area of 603 square miles. In 2013 the area affected by DO concentrations below 4.8 mg/L was estimated at 466 square miles; the smallest area in the 1991-2013 sampling program (CTDEEP, 2013).

Figure 1: Maximum area and duration of hypoxia (DO < 3.0 mg/L) in LIS, 1987-2013 (Welsh, 1990 and CTDEEP, 2013)



The Solution

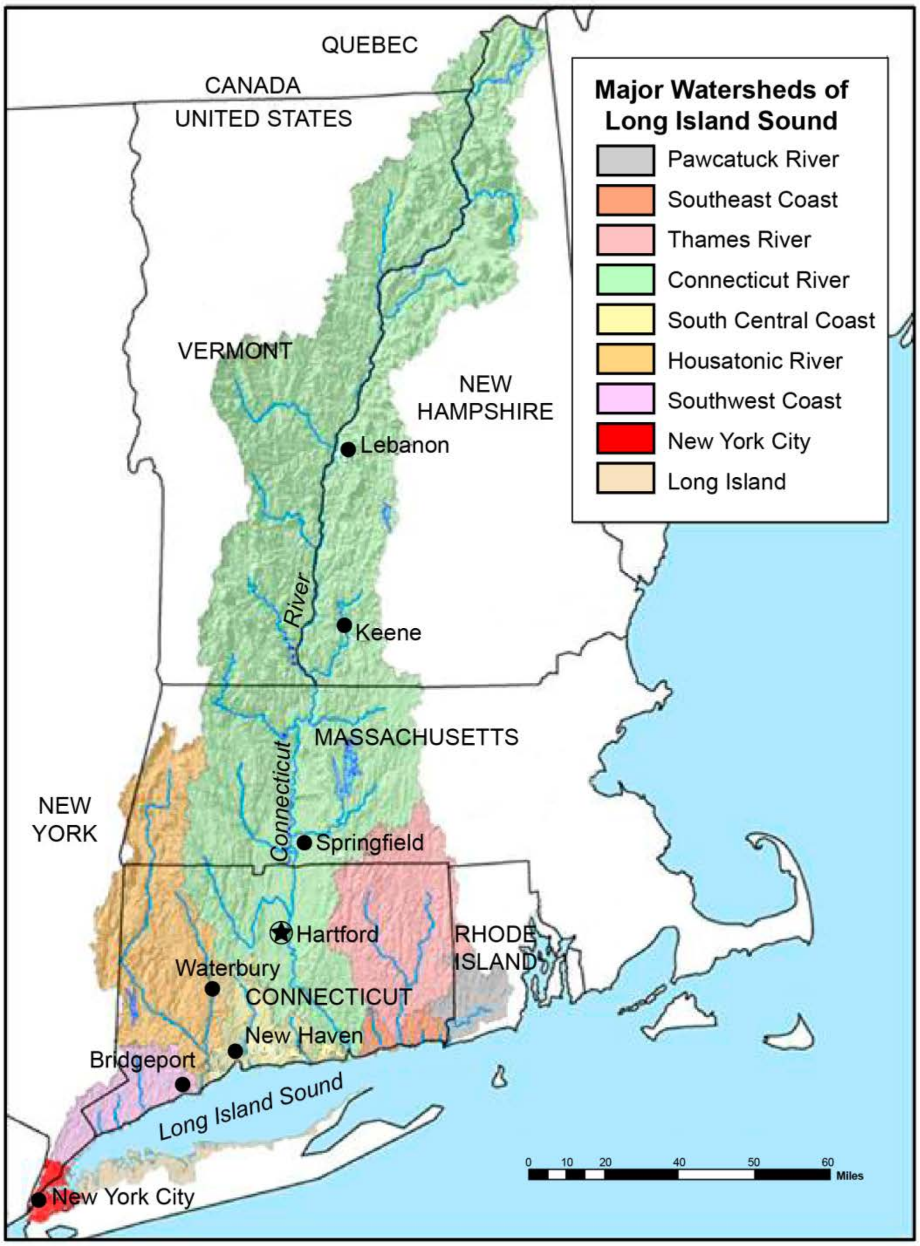
In response to the hypoxic events in LIS, CTDEEP and the New York State Department of Environmental Conservation (NYSDEC) completed "A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound" in 2000, referred to hereafter as "the TMDL." In April 2001, the U.S. Environmental Protection Agency (EPA) approved the TMDL, which identifies actions necessary to attain water quality standards (WQS) for DO in Long Island Sound by 2014. These actions target four areas:

1. Sources of nitrogen within New York and Connecticut (in-basin sources)
    a. 58.5% reduction of point source and nonpoint source (runoff from urban and agricultural land covers) nitrogen loads
2. Upper watershed (or upper basin) sources of nitrogen imported from Massachusetts, New Hampshire, and Vermont through tributaries to the Sound
    a. 25% reduction of point source nitrogen loads and 10% reduction of nitrogen runoff from urban and agricultural land covers
3. Sources of nitrogen deposited from atmospheric emissions
    a. 18% reduction of atmospheric deposition of nitrogen throughout the watershed; expected to be achieved through implementation of federal and regional air emission control programs
4. Alternatives to nitrogen reduction, such as aeration

What We Know

Connecticut and New York are in the process of upgrading treatment plants throughout the LIS watershed to meet nitrogen wasteload allocations expressed in the TMDL. Multiple watershed planning efforts are underway to help address in-basin nonpoint source and stormwater loads as provided for in the TMDL through Section 319, Phase II stormwater permitting, and other state and federal initiatives.

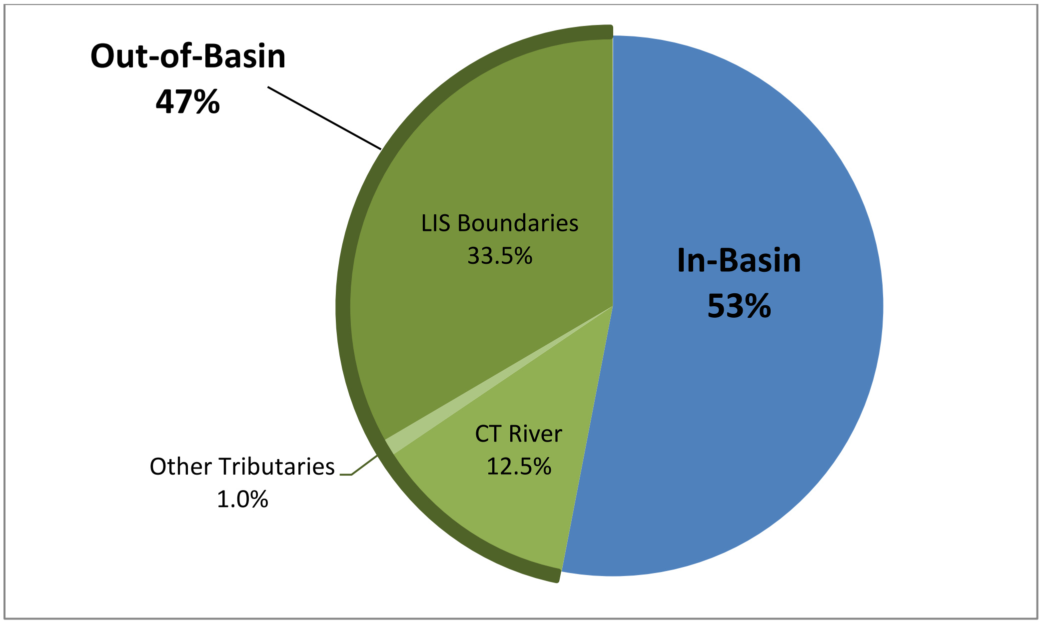
Figure 2: Map of LIS drainage basins



As shown in Figure 2, Connecticut and New York border the Sound, but the watershed extends north through Massachusetts, New Hampshire, and Vermont. The TMDL LAs and WLAs are set for nitrogen load reductions from in-basin and out-of-basin sources. The TMDL defines in-basin (or lower basin) as CT, NY, and LIS surface waters. The TMDL defines out-of-basin as the upper basin (MA, NH, and VT) and the LIS boundaries. The LIS boundaries include New York Harbor, the East River, and the Atlantic Ocean.

Modeling efforts that were used to support development of the TMDL suggest that nearly half (47%) of the total nitrogen load delivered to the Sound is from out-of-basin sources. Figure 3 shows that LIS boundaries contribute an estimated 33.5% of the total nitrogen load delivered to the Sound, followed by the upper Connecticut River (north of the CT/MA border) contributing 12.5%, and 1% from other out-of-basin tributaries including portions of the Farmington, Housatonic, and Thames River basins. Boundary nitrogen loads are delivered to the Sound through the Race, the East River, and the Atlantic Ocean. These boundary loads are mainly from outside the LIS watershed and the jurisdiction of the TMDL. Therefore, this report focuses primarily on in-basin and upper basin nitrogen loads to the Sound.

Figure 3: Nitrogen loading to LIS from in-basin and out-of-basin sources (CTDEEP and NYSDEC, 2000)



Excluding boundary loads, the TMDL's original 1990 baseline load summary estimates that 80% (53% out of 66.5%) of the total nitrogen load delivered to the Sound is from in-basin sources and 20% (13.5% out of 66.5%) is from upper basin tributaries (CTDEEP and NYSDEC, 2000). The in-basin load totaling 53,270.9 tons per year is broken down in Figure 4 by source. The majority of the in-basin load (79%) is from wastewater treatment plants (WWTPs), 2% from combined sewer overflows (CSOs), and the remaining 19% is from nonpoint sources (urban, agriculture, and forested land). The Connecticut, Farmington, Housatonic, and Thames Rivers deliver 13,563 tons per year from out-of-basin; this load is broken down in Figure 5 by source. Unlike the in-basin load, the majority (78%) of the out-of-basin load is from nonpoint sources, and the remaining 22% is from WWTPs, or point sources. Nitrogen loading from atmospheric deposition is included within these TMDL estimates for nonpoint source and regulated stormwater loads. The TMDL estimates that 40.8% of total watershed, 59.5% of the lower basin, and 32.2% of the upper basin nonpoint source and regulated stormwater nitrogen load originates from atmospheric deposition of nitrogen.

Figure 4: In-basin nitrogen load to LIS by source (CTDEEP and NYSDEC, 2000)

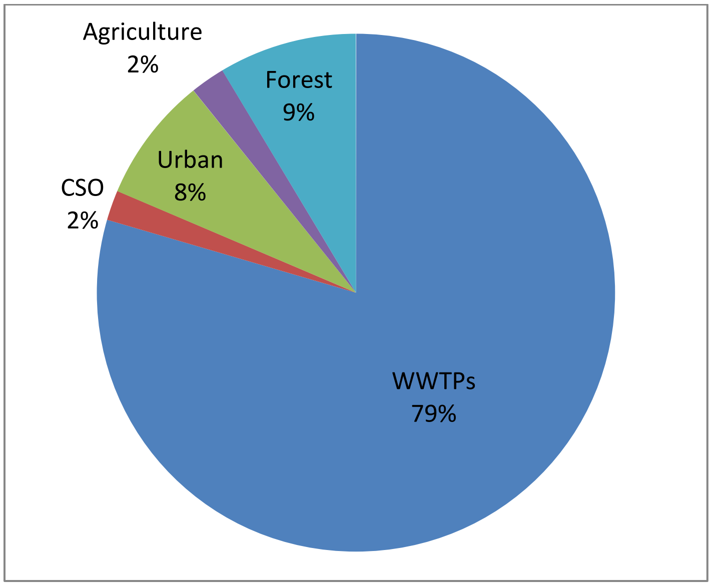
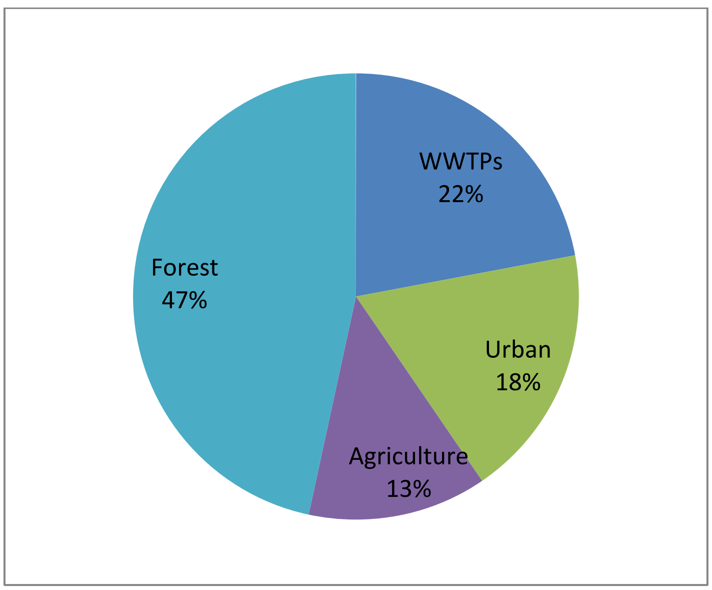


Figure 5: Out-of-basin tributary nitrogen load to LIS by source (CTDEEP and NYSDEC, 2000)



TMDL Phased Implementation & Reassessment

The TMDL has a phased implementation plan, which included commitments to reevaluate nitrogen reduction targets periodically and prepare revised TMDLs accordingly. The TMDL reevaluation process has been underway since adoption of the original TMDL. The phased implementation plan schedule for the 2000 the TMDL calls for a reevaluation of the allocations based upon advances in monitoring, modeling, research, implementation, water quality criteria, and other factors. That reevaluation is currently supported by LISS. A future TMDL revision may include updated nitrogen allocations for both in-basin sources (CT and NY) and out-of-basin sources. Advances in five areas, in particular, are being considered in the reassessment:

1. In response to EPA's regional marine DO criteria published in 2000, Connecticut and New York adopted DO standards for LIS and recently (2011) revised these standards.
2. LISS has adopted the System-Wide Eutrophication Model (SWEM) for water quality planning, which succeeds the LIS 3.0 water quality model. Several modeling scenarios have been completed.
3. LISS has supported a more detailed assessment of nitrogen sources and delivery from the Connecticut River through trend analyses and modeling efforts.
4. There is an improved understanding of nutrient sources and the opportunities and costs of source management.
5. LISS is investigating the use of bioextraction to reduce nitrogen concentrations as an alternative management scenario.

TMDL Enhanced Implementation Plan

In 2012, the LISS Management Committee and the five watershed states approved a framework for TMDL assessment known as the Enhanced Implementation Plan (EIP) for the original TMDL. The EIP contains three main elements: (1) continue with implementation of nitrogen reductions from wastewater treatment plants (upgrades and optimization work in the lower basin and capping loads and monitoring in the upper basin), (2) complete a preliminary evaluation of current stormwater and nonpoint source control efforts with a goal of qualitatively assessing their adequacy for meeting the 2000 TMDL load allocations, and (3) develop and implement a feasible tracking system to evaluate attainment of load allocations for nonpoint sources and wasteload allocations for regulated stormwater sources.

This report represents part two of the EIP, serving as a preliminary evaluation of current stormwater and nonpoint source control efforts with a goal of qualitatively assessing whether they are adequate for meeting the 2000 TMDL load allocations (LAs). This qualitative analysis is based on (1) nitrogen loading trends, (2) changes in drivers of nitrogen loading, and (3) the scope and effectiveness of on-the-ground nonpoint source and stormwater nitrogen control efforts.

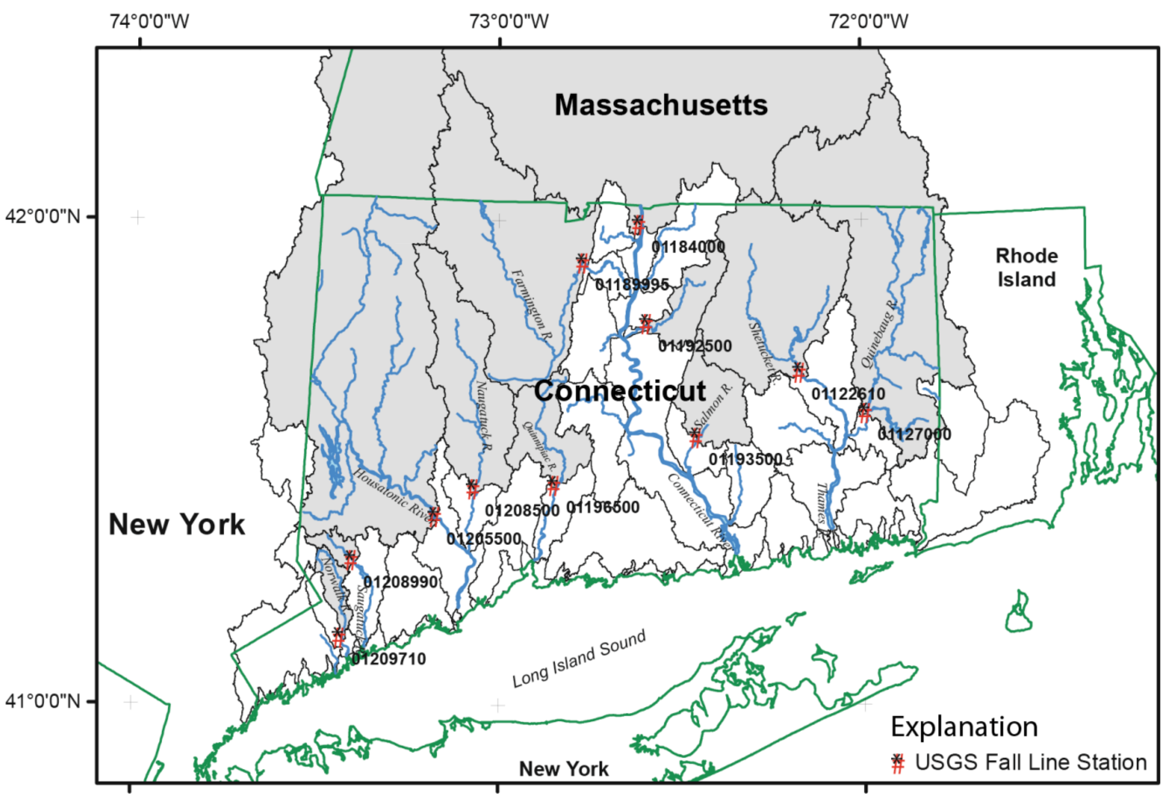
Each of the five watershed states conducted individual analyses based on the information that is available to them at the state level. The five state sections of this report explain each state's approach as well as the findings, recommendations, and conclusions. Evidence from the state sections used in this watershed summary is referenced to the state environmental agency and page number.

Nitrogen Load Trends Analysis

Surface Water

Existing nitrogen load trend analyses serve as a direct measure of TMDL implementation. Latimer et al. (2013) explain the results of a U.S. Geological Survey (USGS) trend analysis of nitrogen loading to the Sound from 1974 to 2008. The trend analysis is based on water quality data for nitrogen from the USGS water quality monitoring network including 11 selected fall line streamgages (above tidal influence) and water quality monitoring locations in Connecticut tributaries, including the Connecticut, Farmington, Housatonic, Naugatuck, Quinnipiac, Shetucket, and Quinebaug Rivers, as shown in Figure 6 below.

Figure 6: USGS network of streamgages and water quality monitoring sites in the LIS watershed (Latimer et al., 2013)



The analysis found that nitrogen concentrations and loads in tributaries and the Sound have generally declined between 1974 and 2008, with the exception of the Quinnipiac River (dominated by point sources) and the Saugatuck River (75% forested). However, most of the reductions occurred in earlier years, with loads stabilizing or slightly increasing in recent years, possibly due to increased precipitation and river flow. Nitrogen concentrations generally showed no significant trend in later years.

USGS is currently conducting a similar analysis to analyze trends in nitrogen loading to LIS from 1999 to 2009, accounting for the influence of wet weather on nitrogen loading. The results of this study will enhance understanding of the influence of TMDL implementation efforts on nitrogen loading to LIS since the time period more closely correlates with the TMDL implementation time period. Furthermore, the 1999-2009 analysis will provide insight on wet weather as a nitrogen loading driver or stressor and its influence on (1) nitrogen loading from stormwater and nonpoint sources and (2) the effectiveness of stormwater and nonpoint source management efforts.

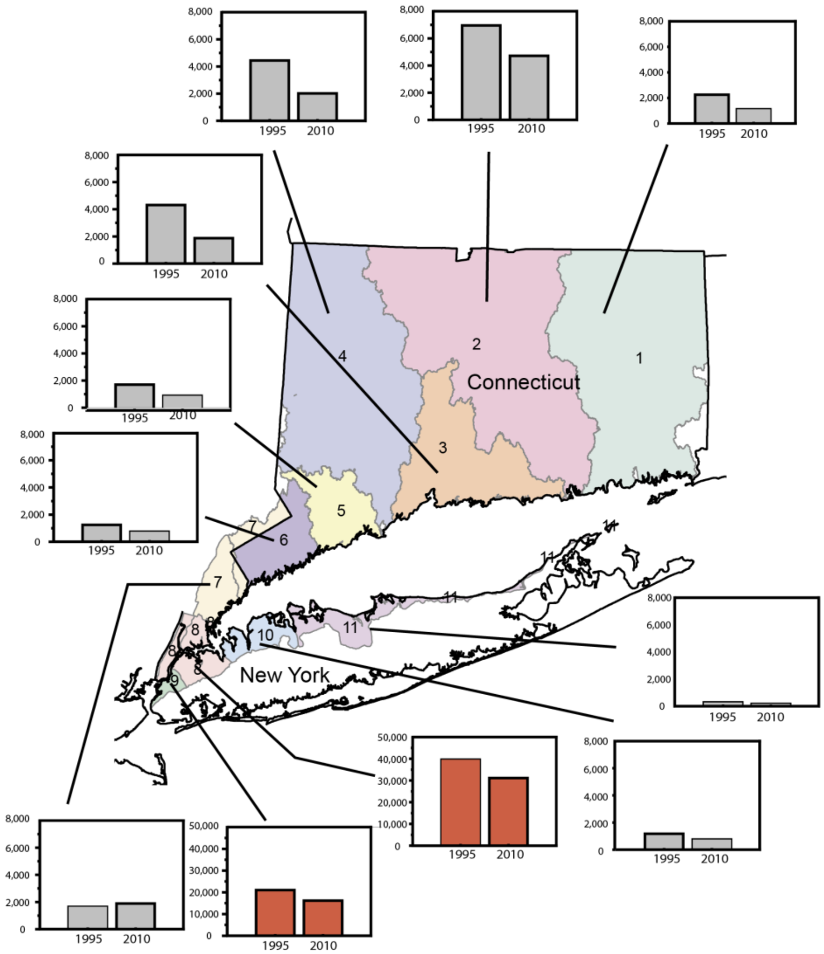
Groundwater

Groundwater nitrogen loading also influences the success of TMDL implementation. The loading of nitrogen from groundwater can be a component of tributary loads or can be a direct discharge to coastal embayments along the CT and NY shoreline. The transit time of groundwater from the source of recharge to a tributary or LIS embayment can be long (multiple years and even decades in some cases), delaying the effects of land use changes or management actions on receiving waters. On Long Island, NY, in particular, the groundwater contribution of nitrogen has increased relative to surface water runoff due to high recharge in glacial moraine sediments. A Suffolk County Department of Health Services draft report (2010) provides insight into possible broader trends in groundwater loading. In the report's comparison of water quality data collected from community supply wells that were sampled in both 1987 and in 2005, the concentrations of nitrate in three aquifers increased. This is attributed to increased sanitary wastewater discharges and fertilization practices. A comparison of average nitrate concentrations from all community supply wells that existed in 1987 and all community supply wells that existed in 2005 showed that nitrate concentrations, on average, have increased by more than 1 mg/L in both the upper glacial and deeper Magothy aquifers. In other words, nitrate concentrations increased by 40% in the aquifer closest to the surface and increased 200% in nitrates in the deeper Magothy aquifer from 1987 to 2005.

In-Basin Wastewater Treatment Plants

Although the intent of this report is not to analyze the scope and effectiveness of nitrogen management practices at WWTPs, point sources are significant nitrogen contributors to in-basin nitrogen loads. As shown in Figure 7, WWTP nitrogen loads from CT and NY to the Sound were found to have decreased from 1995 to 2010. In 1995, end-of-pipe nitrogen loads averaged 46,297 pounds per day in CT and 141,095 pounds per day in NY. In 2010, those loads had dropped to 24,912 pounds per day in CT and 110,231 pounds per day in NY – a decrease of 46% in CT and 22% in NY since 1995 (Latimer et al., 2013). The decrease in WWTP loading during this time period is attributed to wastewater management programs, including CT's Nitrogen Credit Exchange Program initiated in 2002 and NY's WWTP permitting strategy.

Figure 7: Change in Connecticut and New York WWTP nitrogen loading (kg/day) by watershed-based zone, 1995-2010 (Latimer et al., 2013)



Atmospheric Deposition

According to the TMDL's original baseline load summary of total nitrogen loading as delivered to LIS, 40.8% of the total nonpoint source and regulated stormwater load originates from atmospheric nitrogen deposition. In setting the WLAs and LAs, the original TMDL considered that an 18% reduction in atmospheric nitrogen deposition is anticipated from implementation of the Clean Air Act Amendments (CAAA) of 1990 based on the Regional Acid Deposition Model (RADM) estimates. An 18% reduction in atmospheric nitrogen would reduce nitrogen loads to the Sound by 1,524 tons per year. More aggressive atmospheric nitrogen management beyond the requirements of the CAA, such as a 50% reduction, would reduce nitrogen loads to the Sound by an additional 2,700 tons per year. Such reductions in atmospheric nitrogen would increase the TMDL margin of safety and likely result in nitrogen load reductions from nonpoint source and stormwater sources.

The National Atmospheric Deposition Program's National Trends Network (NADP NTN) monitors total wet deposition and precipitation-weighted mean concentrations of nitrate (NO_3) and ammonium (NH_4). Active NADP NTN monitoring stations that are within or near the LIS watershed are listed in Table 1 below. Data collected from these sites may indicate trends in atmospheric deposition sources of nitrogen throughout the watershed relative to the TMDL baseline.

Table 1: Active NADP NTN monitoring sites within or near the LIS watershed

Site ID	Location	Years in Operation
NY96	Suffolk County, NY	2003-Present
NY99	Orange County, NY	1983-Present
CT15	Windham County, CT	1999-Present
MA08	Franklin County, MA	1982-Present
VT01	Bennington County, VT	1981-Present
VT99	Chittenden County, VT	1984-Present
NH02	Grafton County, NH	1978-Present

Changes in total wet deposition of nitrate and ammonium as well as mean precipitation between 1990 (TMDL baseline) and 2012 are shown in Figure 8 and Figure 9 (NADP, 2013). Atmospheric wet deposition of nitrate decreased by approximately 50% from 20 kg/ha in 1990 to 9 kg/ha in 2012. Data on atmospheric wet deposition of ammonium, however, does not suggest any trend. The significant reduction in nitrate from wet deposition is likely attributed to the Clean Air Act Amendments (CAAA) of 1990 and the resulting actions to reduce nitrogen oxide (NOx) emissions. Wet nitrogen deposition is largely influenced by precipitation, and most peaks in wet nitrogen deposition are correlated with peaks in precipitation.

Figure 8: Total wet nitrate (NO_3) deposition and precipitation, water years 1990-2012 (NADP NTN)

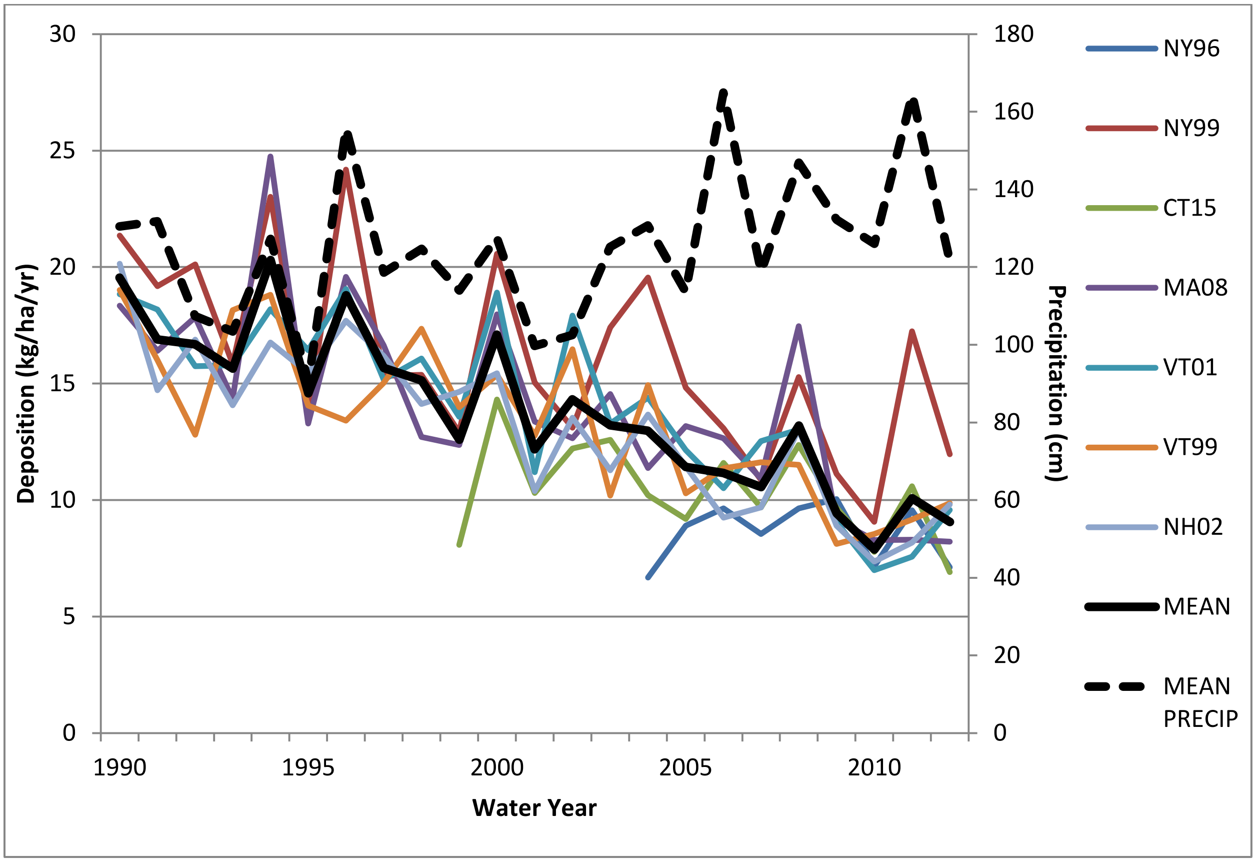
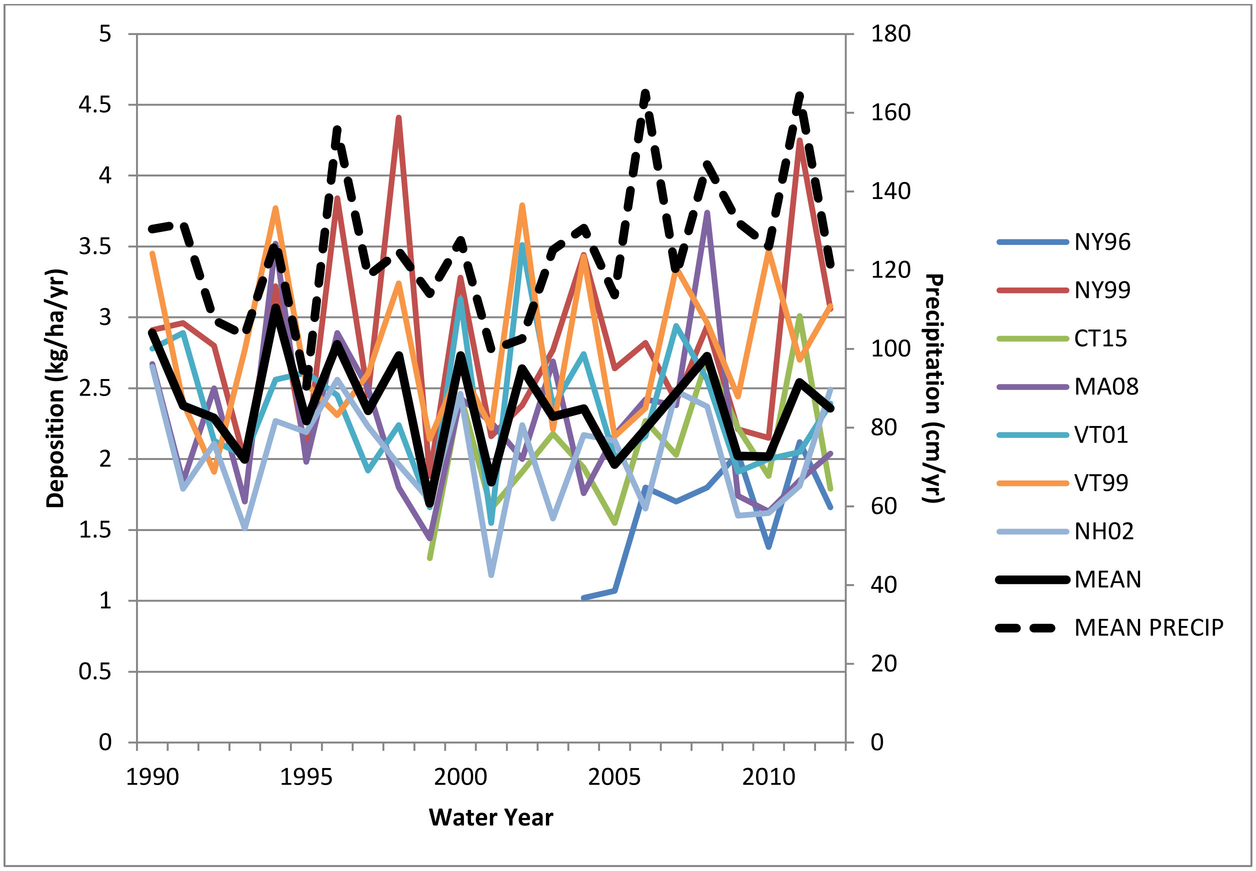


Figure 9: Total wet ammonium (NH_4) deposition and precipitation, water years 1990-2012 (NADP NTN)



According to the EPA Clean Air Status and Trends Network (CASTNET), wet deposition contributes more than 75% of total nitrogen deposition (wet and dry) in New England and New York (EPA, 2013). Therefore, patterns in precipitation heavily influence atmospheric nitrogen deposition. The change in precipitation-weighted mean concentrations from 1990 to 2012 is shown for NO_3 in Figure 10 and NH_4 in Figure 11. These measures are more representative of NOx emission controls and less influenced by precipitation. However, concentrations of NO_3 show the same 50% decrease as seen with the wet precipitation data, declining from 1.50 mg/L in 1990 to 0.75 mg/L in 2012. NH_4 displays no significant change.

Figure 10: Precipitation-weighted mean concentrations for nitrate (NO_3) deposition, water years 1990-2012 (NADP NTN)

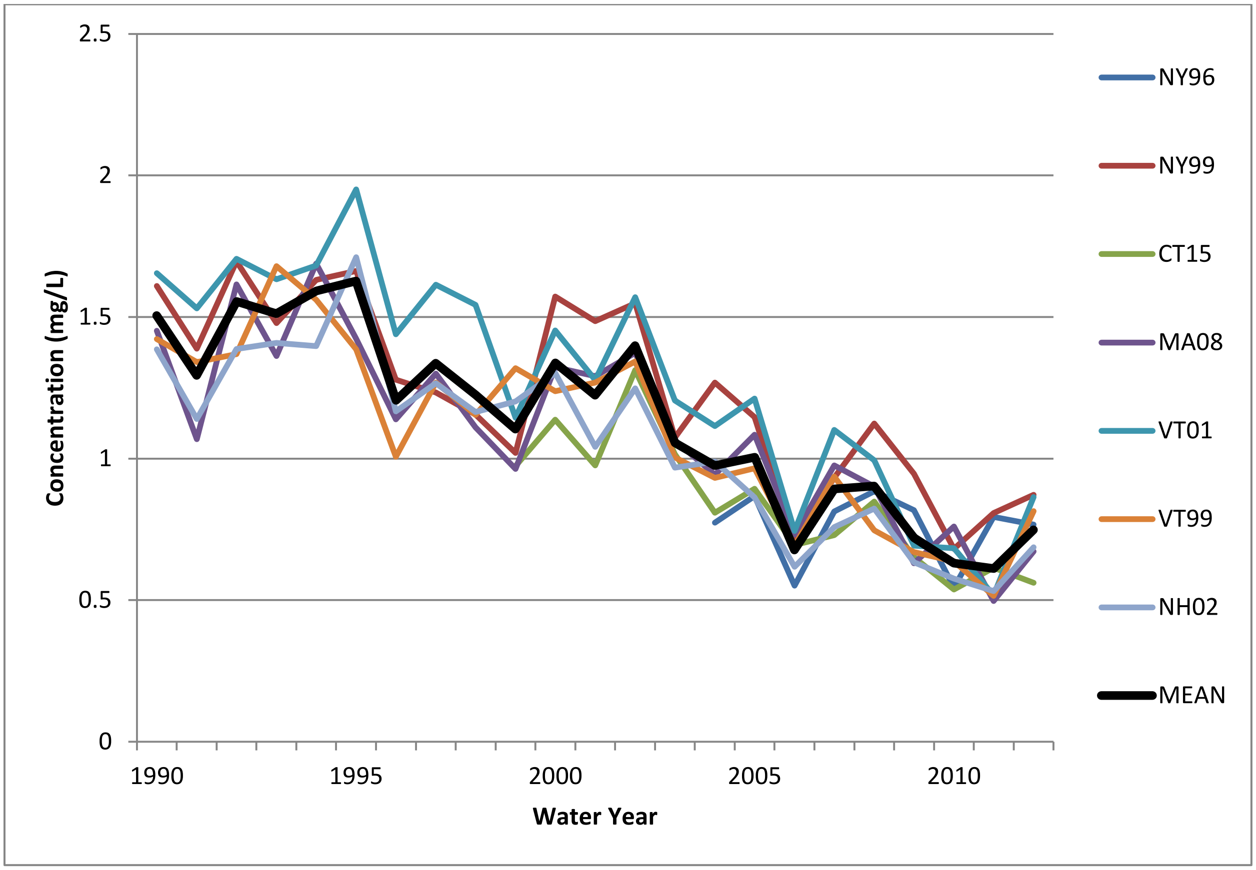
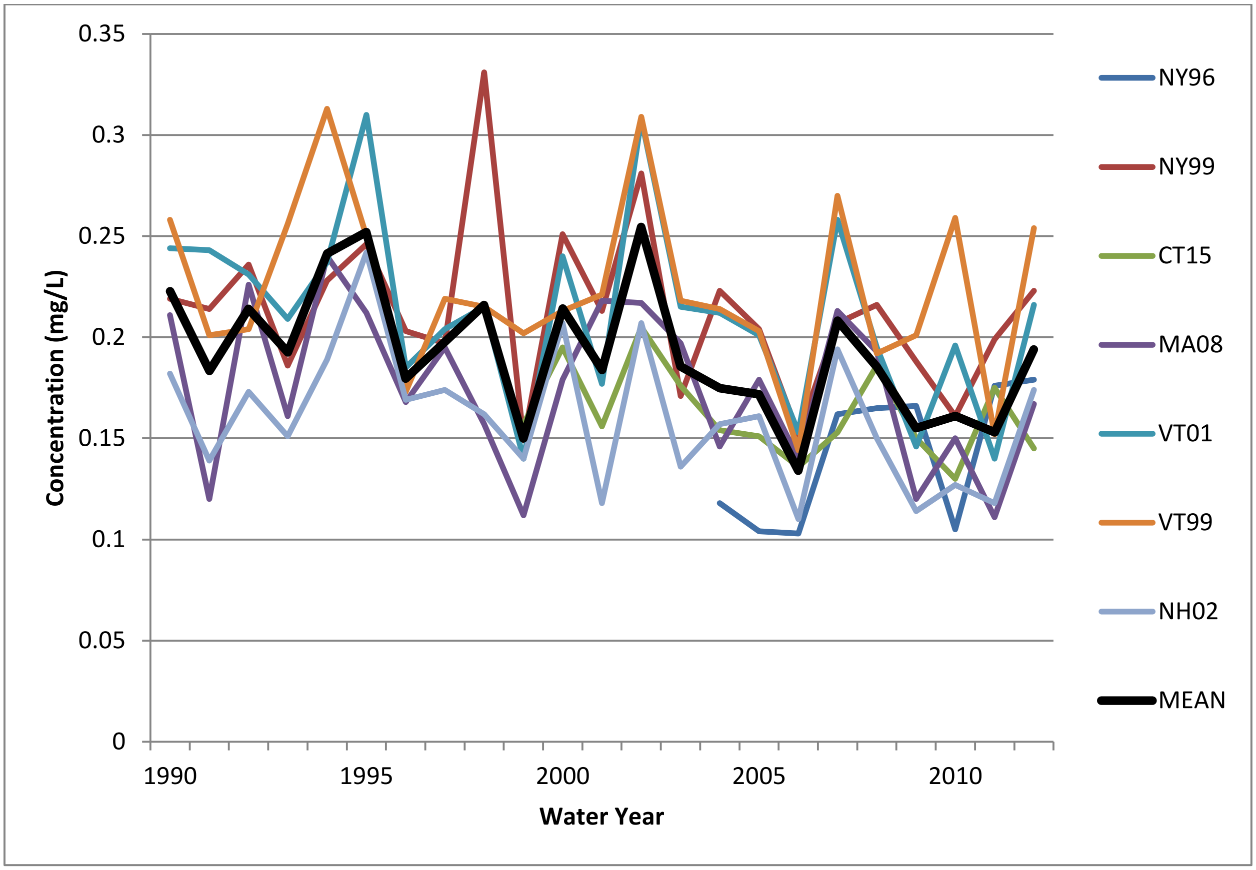


Figure 11: Precipitation-weighted mean concentrations for ammonium (NH_4) deposition, water years 1990-2012 (NADP NTN)



Data from 34 CASTNET eastern reference sites further confirm the trends suggested by data from the NADP NTN monitoring sites within or near the LIS watershed. Estimates of trends from CASTNET data show an overall slow downward trend in precipitation-weighted mean nitrogen concentrations, with increases in 2010 and 2011 (EPA, 2013). Total nitrogen deposition (wet and dry) declined 26% from 1990 to 2011 (EPA, 2013). In 2010 and 2011, total nitrogen deposition increased 33%, concurrent with the highest average annual rainfall rate during the study period (EPA, 2013).

A Developing Watershed

Change in land cover and land use may drive changes in nitrogen loading from stormwater and nonpoint sources to the Sound. For example, an increase in developed or agricultural land cover would likely indicate an increase in nitrogen loading stressors, while an increase in forested land cover would likely point to a decrease in nitrogen stressors. Indicators of development include increases in developed and impervious land cover, loss of forested land cover, and population growth as well as changes in stormwater infrastructure and associated permitting needs, septic systems, and residential fertilizer use. Agricultural indicators include changes in hay/pasture and row crop land covers, animal populations, and amounts of fertilizer/manure spread. This section evaluates watershed land cover and land use change in order to better understand the change in drivers of nitrogen loading since 1990 and the influence on TMDL implementation success.

Land Cover & Population Change

For the purpose of this report, EPA completed a Geographic Information System (GIS)-based analysis using National Land Cover Dataset (NLCD) land cover change data from 2001 to 2006[1] and population growth data from the U.S. Census Bureau from 1990 to 2010 for the LIS watershed study area. NLCD indicators selected for this analysis include developed, impervious, forested, and agricultural land cover.[2]

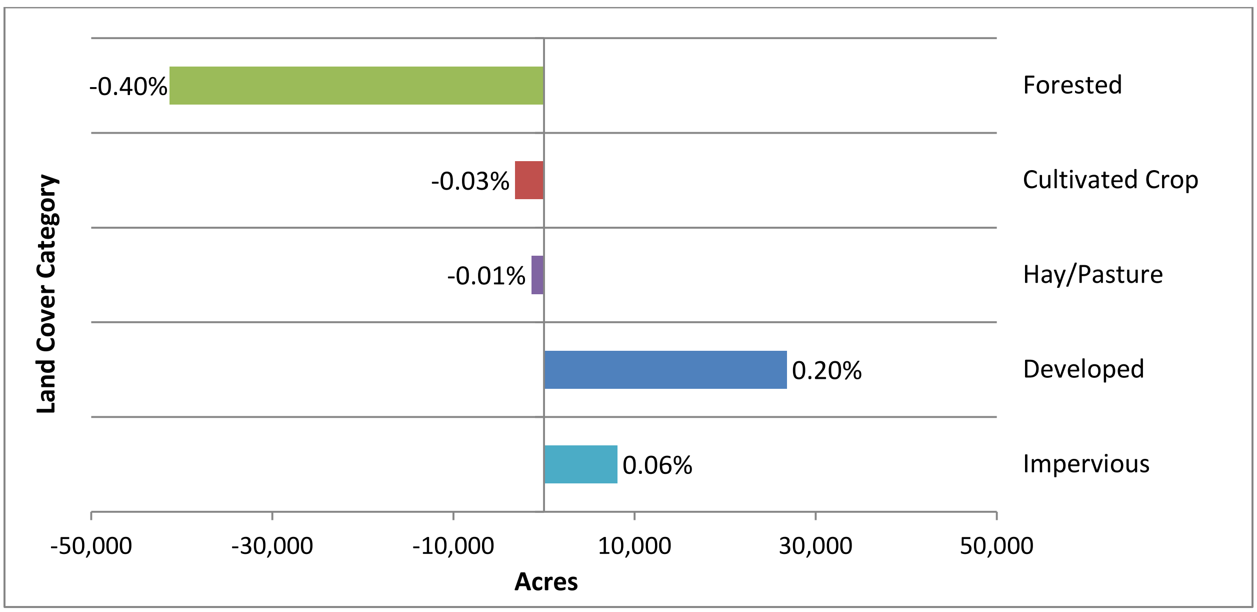
Figure 12 summarizes land cover changes as the total increase or decrease in acres watershed-wide between 2001 and 2006. Developed land cover (as a percentage of total watershed area) increased by 0.20% (26,808 acres) from 13.82% in 2001 to 14.02% in 2006 and impervious cover (a subset of developed land cover) increased by 0.06% (8,093 acres) from 3.46% in 2001 to 3.51% in 2006. Agricultural land classified as hay/pasture decreased by 0.01% (1,392 acres) from 5.58% in 2001 to 5.57% in 2006 and agricultural land classified as cultivated crop decreased by 0.03% (3,165 acres) from 1.47% in 2001 to 1.44% in 2006. Forested land also decreased by 0.40% (41,320) acres from 70.65% in 2001 to 70.25% in 2006 (NLCD, 2013). These changes indicate the watershed is experiencing continued development and that the conversion of land from agriculture and forested lands to developed lands is likely occurring.

[1] Due to changes in the methodologies employed, older NLCD maps are not directly comparable, limiting the analysis to the 2001-2006 timeframe.

[2] The developed land cover category includes land cover classified as open space (some constructed materials, lawn and grasses) and low intensity, medium intensity, and high intensity development. Impervious land cover calculations are based on percent imperviousness of the developed land cover classifications. Imperviousness of open space is less than 20%, low intensity is 20-49%, medium intensity is 50-79%, and high intensity is greater than 79%. The forested land cover category includes deciduous, evergreen, and mixed forest. The agricultural land cover category includes land cover classified as pasture/hay and row crops. Pasture/hay land cover includes areas of grass and/or legume livestock grazing and seed or hay crops production. Row crop land cover includes areas for production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and perennial woody crops, such as orchards and vineyards.

Additionally, the watershed population grew by 402,065 and population density increased by 28.8 persons per square mile or 8% from 1990 to 2010 (U.S. Census Bureau). Population growth indicates increases in wastewater volume. Where WWTP permits cap the nitrogen load, an increase in wastewater loads in sewered areas will require increased treatment. However, population growth in un-sewered watersheds indicates a possible increase in nitrogen load from septic systems or decentralized wastewater via groundwater. According to the U.S. Census of Housing, in 1990 septic tanks managed sanitary waste for 29% of CT households, 28% of MA households, 49% of NH households, 20.2% of NY households, and 55% of VT households (statewide, not LIS watershed portion of states). These U.S. Census of Housing data are not available in the 2010 census. However, CTDEEP's Municipal Facilities Section provided 2010 data for the purpose of this report. In CT the percent of households managing sanitary waste with septic systems increased from approximately 29% to 38%, which is equal to about a 10% increase in decentralized wastewater (CTDEEP, p. 18). Assuming the use of septic systems relative to use of sewer systems to manage household sanitary waste is increasing in all LIS watershed states while population throughout the region continues to grow, it is possible to infer that the Sound is experiencing an increase in drivers of nitrogen loading associated with septic systems.

Figure 12: Land cover change in the LIS watershed by acres, 2001-2006 (NLCD)



The GIS-based maps in Figures 13-17 show the distribution of land cover changes and population growth throughout the watershed. Developed land, impervious cover, and population have increased and forested land cover has decreased in all five watershed states, indicating development in the watershed is continuing. The in-basin portion of the watershed (CT and NY) is developing at a faster rate than the upper basin portion.

These NLCD data are helpful in detecting overall watershed trends in land cover and land use change. Finer resolution land cover and land use data are also available and described in the following sections to better understand how these changes may influence nitrogen loading to the Sound.

Figure 13: Map of developed land cover change in the LIS watershed, 2001-2006 (NLCD)

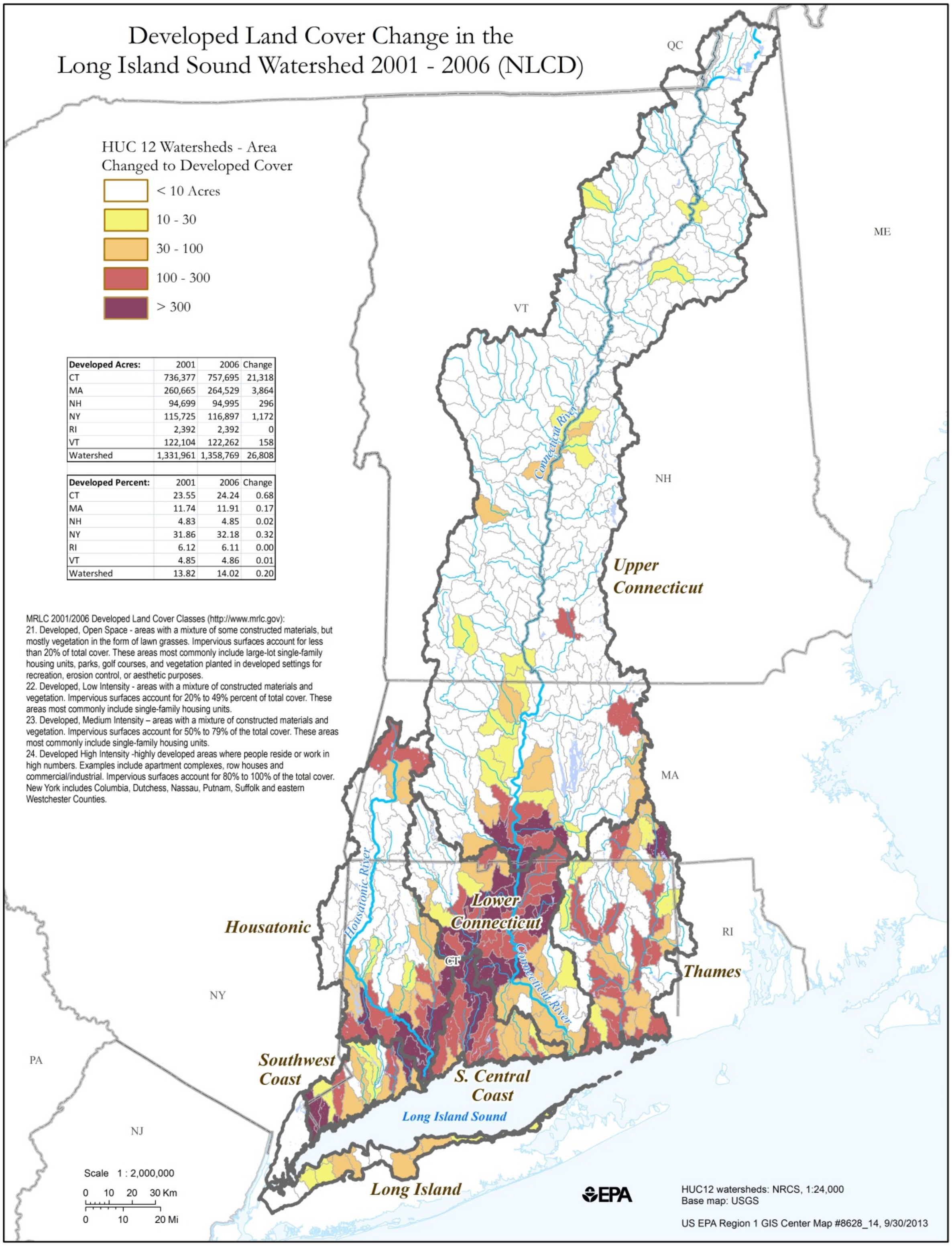
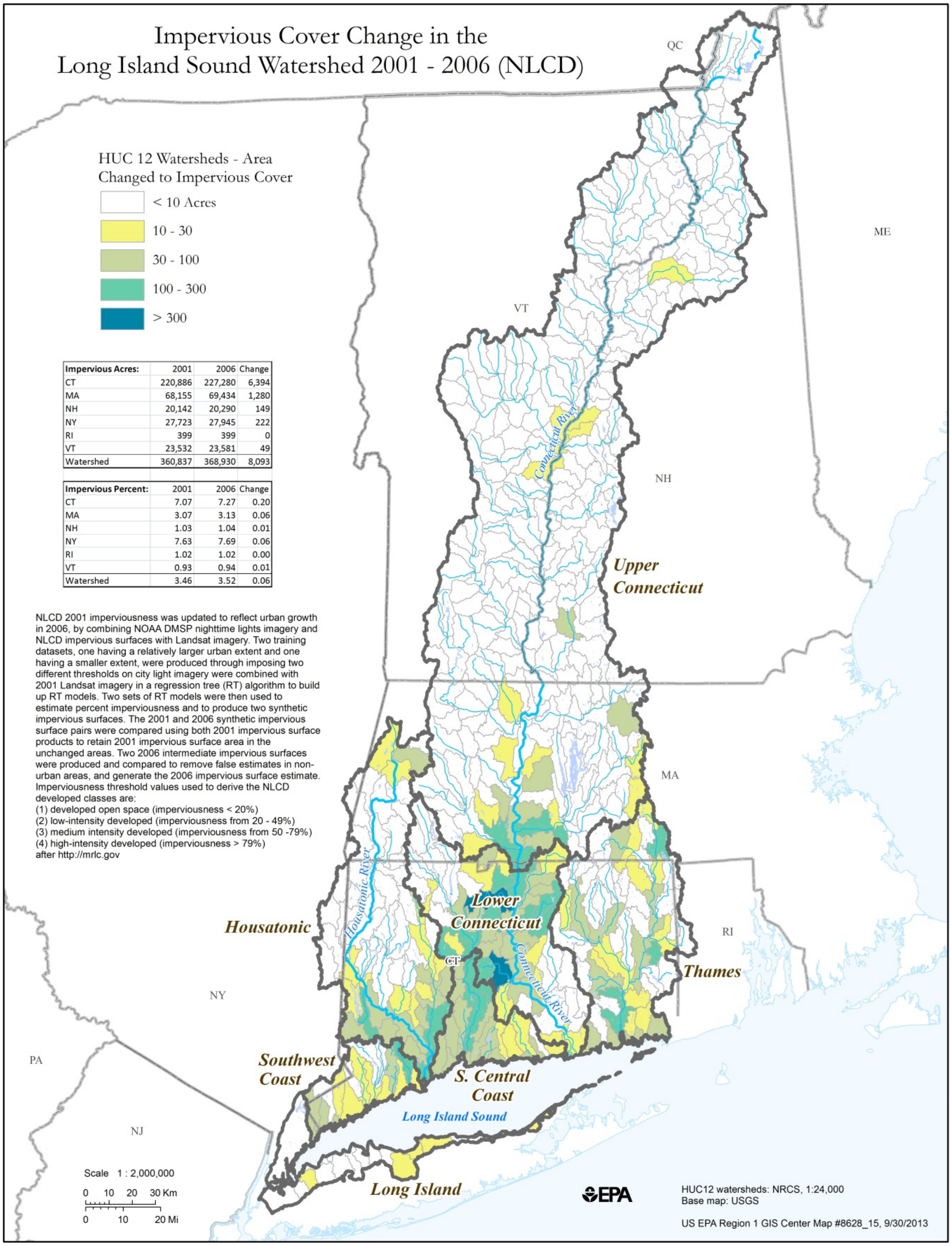


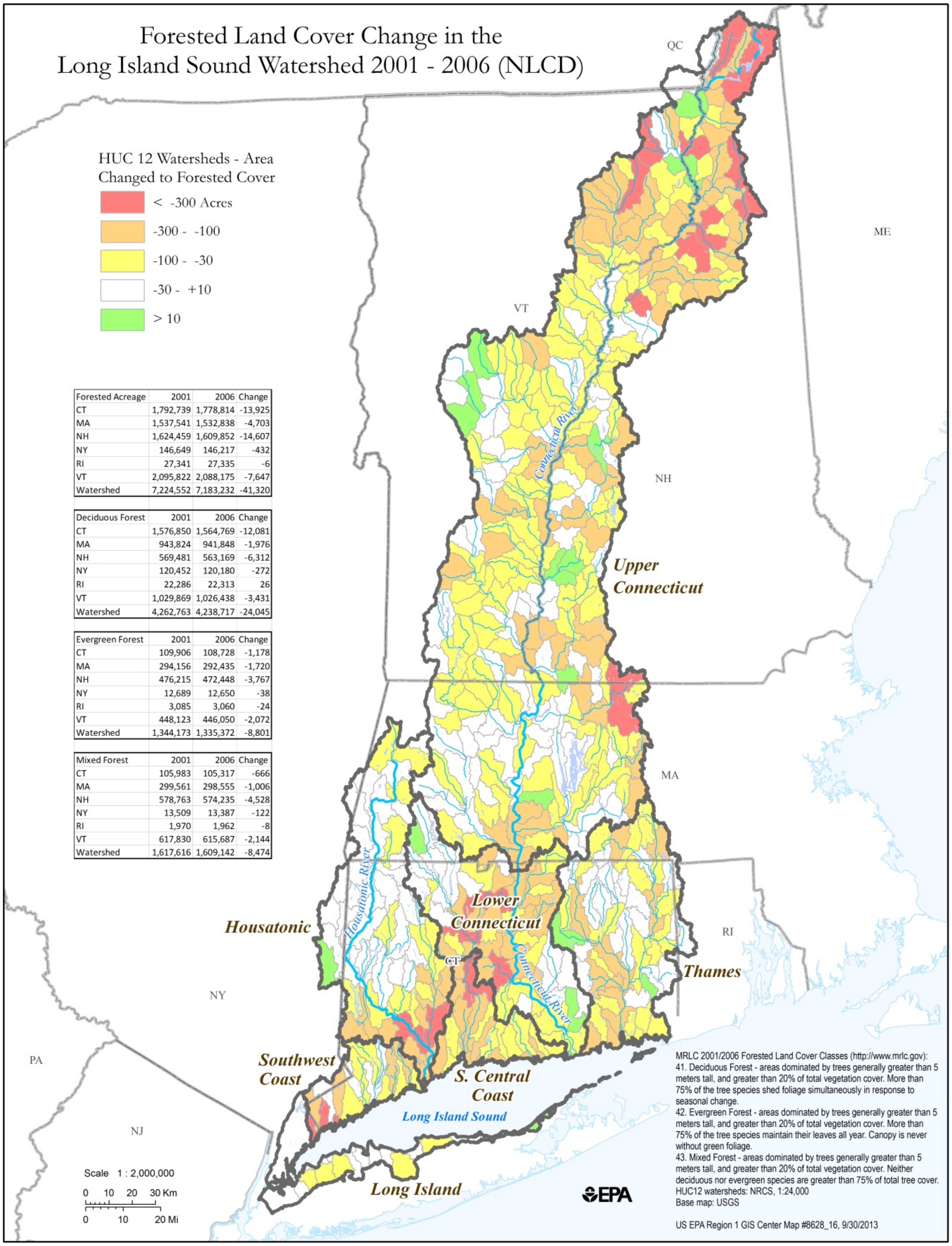
Figure 14: Map of impervious cover change in the LIS watershed, 2001-2006 (NLCD)



Impervious Acres:	2001	2006	Change
CT	220,886	227,280	6,394
MA	68,155	69,434	1,280
NH	20,142	20,290	149
NY	27,723	27,945	222
RI	399	399	0
VT	23,532	23,581	49
Watershed	360,837	368,930	8,093

Impervious Percent:	2001	2006	Change
CT	7.07	7.27	0.20
MA	3.07	3.13	0.06
NH	1.03	1.04	0.01
NY	7.63	7.69	0.06
RI	1.02	1.02	0.00
VT	0.93	0.94	0.01
Watershed	3.46	3.52	0.06

Figure 15: Map of forested land cover change in the LIS watershed, 2001-2006 (NLCD)



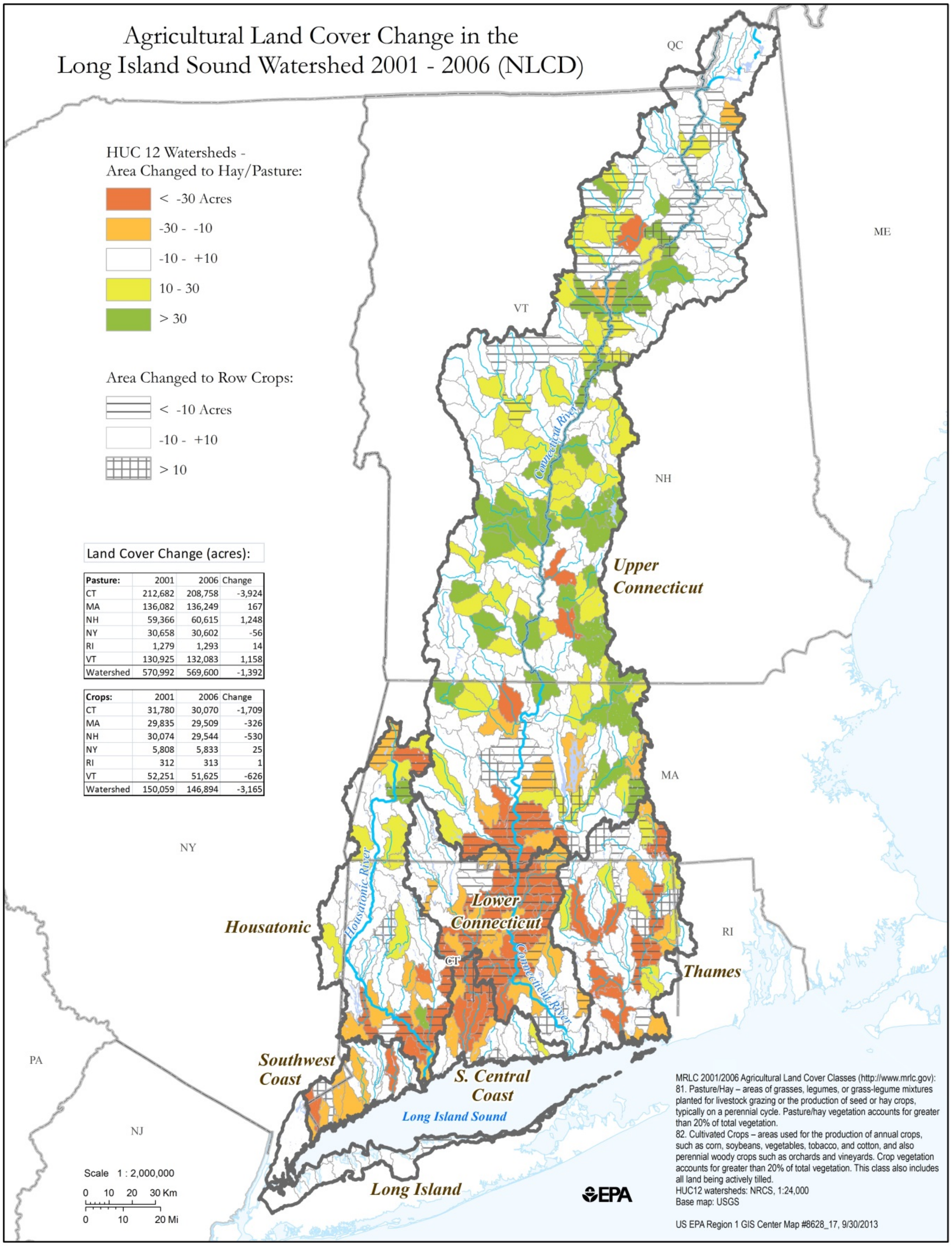
Forested Acreage	2001	2006	Change
CT	1,792,739	1,778,814	-13,925
MA	1,537,541	1,532,838	-4,703
NH	1,624,459	1,609,852	-14,607
NY	146,649	146,217	-432
RI	27,341	27,335	-6
VT	2,095,822	2,088,175	-7,647
Watershed	7,224,552	7,183,232	-41,320

Deciduous Forest	2001	2006	Change
CT	1,576,850	1,564,769	-12,081
MA	943,824	941,848	-1,976
NH	569,481	563,169	-6,312
NY	120,452	120,180	-272
RI	22,286	22,313	26
VT	1,029,869	1,026,438	-3,431
Watershed	4,262,763	4,238,717	-24,045

Evergreen Forest	2001	2006	Change
CT	109,906	108,728	-1,178
MA	294,156	292,435	-1,720
NH	476,215	472,448	-3,767
NY	12,689	12,650	-38
RI	3,085	3,060	-24
VT	448,123	446,050	-2,072
Watershed	1,344,173	1,335,372	-8,801

Mixed Forest	2001	2006	Change
CT	105,983	105,317	-666
MA	299,561	298,555	-1,006
NH	578,763	574,235	-4,528
NY	13,509	13,387	-122
RI	1,970	1,962	-8
VT	617,830	615,687	-2,144
Watershed	1,617,616	1,609,142	-8,474

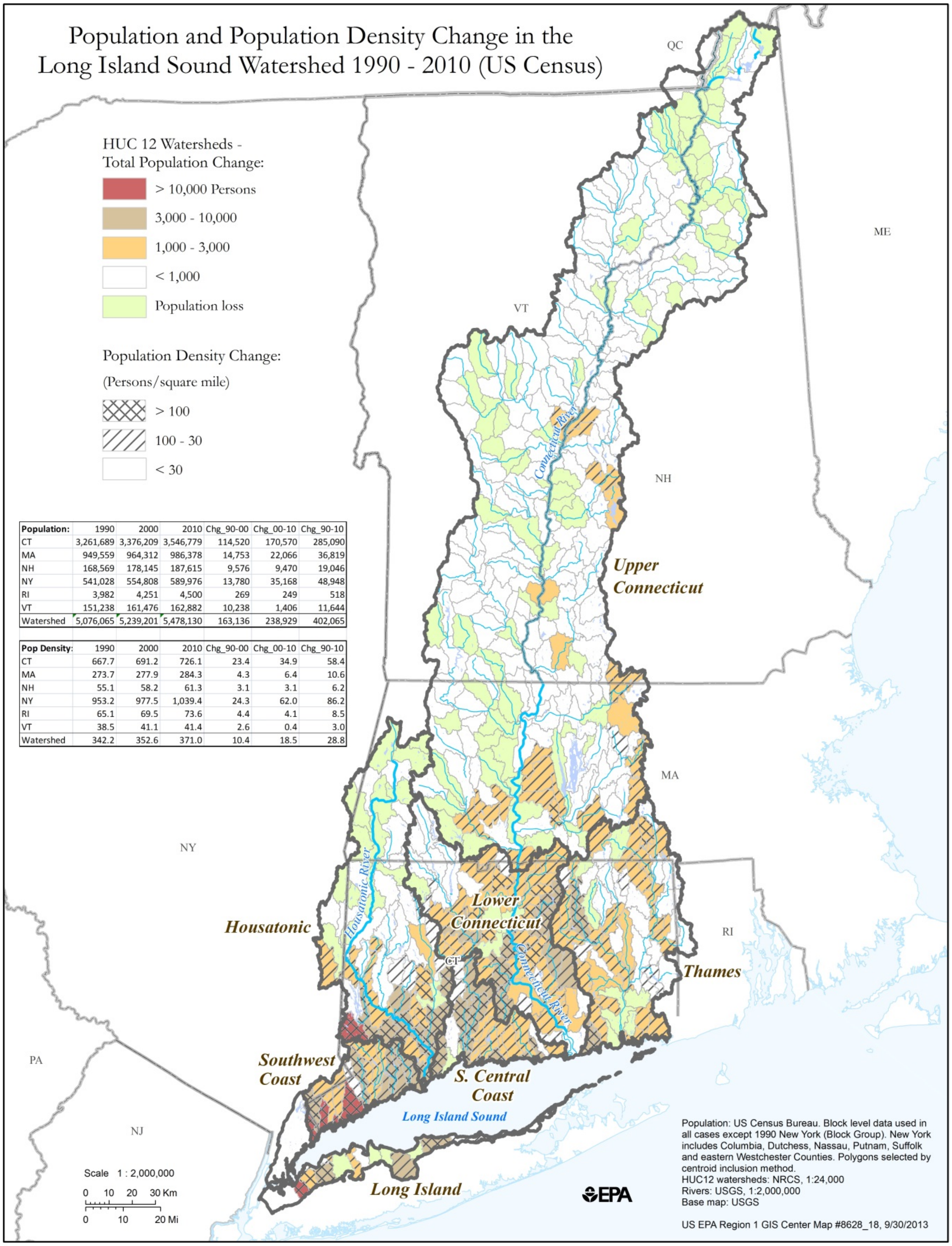
Figure 16: Map of agricultural land cover change (row crops and hay/pasture) in the LIS watershed, 2001 -2006 (NLCD)



Pasture:	2001	2006	Change
CT	212,682	208,758	-3,924
MA	136,082	136,249	167
NH	59,366	60,615	1,248
NY	30,658	30,602	-56
RI	1,279	1,293	14
VT	130,925	132,083	1,158
Watershed	570,992	569,600	-1,392

Crops:	2001	2006	Change
CT	31,780	30,070	-1,709
MA	29,835	29,509	-326
NH	30,074	29,544	-530
NY	5,808	5,833	25
RI	312	313	1
VT	52,251	51,625	-626
Watershed	150,059	146,894	-3,165

Figure 17: Map of population and population density change in the LIS watershed, U.S. Census Bureau Data, 1990-2010



Population:	1990	2000	2010	Chg_90-00	Chg_00-10	Chg_90-10
CT	3,261,689	3,376,209	3,546,779	114,520	170,570	285,090
MA	949,559	964,312	986,378	14,753	22,066	36,819
NH	168,569	178,145	187,615	9,576	9,470	19,046
NY	541,028	554,808	589,976	13,780	35,168	48,948
RI	3,982	4,251	4,500	269	249	518
VT	151,238	161,476	162,882	10,238	1,406	11,644
Watershed	5,076,065	5,239,201	5,478,130	163,136	238,929	402,065

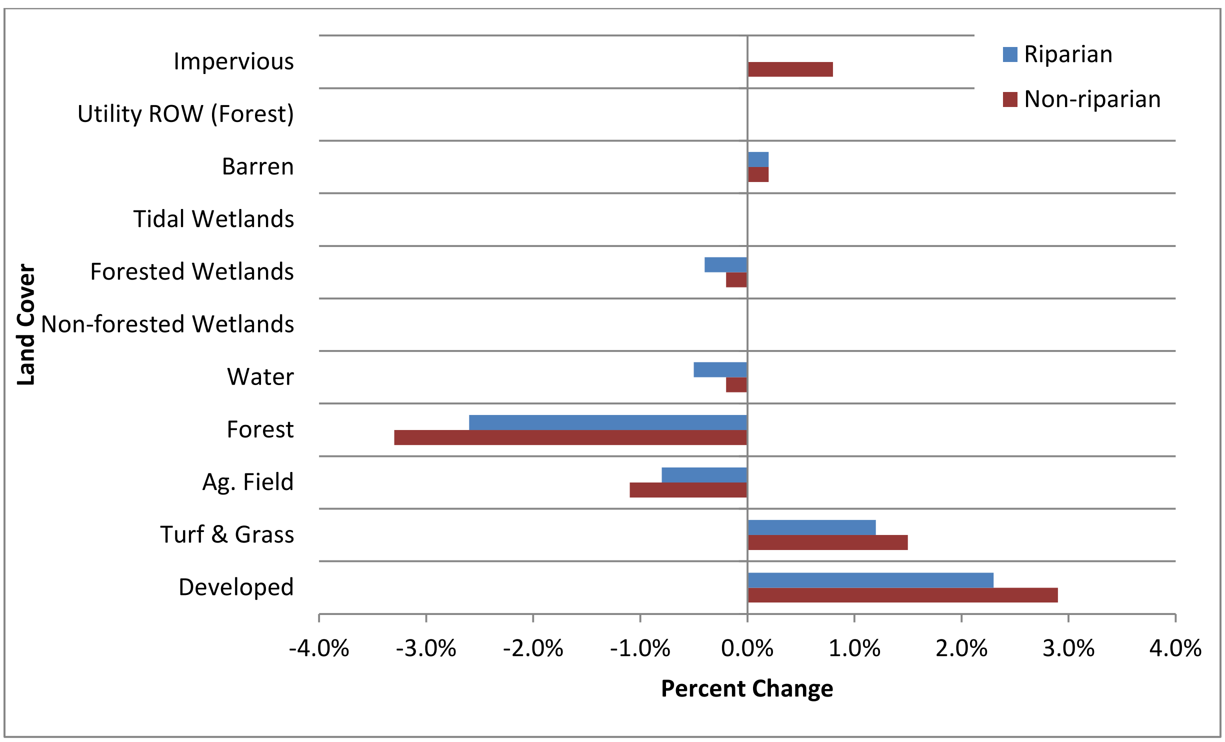
Pop Density:	1990	2000	2010	Chg_90-00	Chg_00-10	Chg_90-10
CT	667.7	691.2	726.1	23.4	34.9	58.4
MA	273.7	277.9	284.3	4.3	6.4	10.6
NH	55.1	58.2	61.3	3.1	3.1	6.2
NY	953.2	977.5	1,039.4	24.3	62.0	86.2
RI	65.1	69.5	73.6	4.4	4.1	8.5
VT	38.5	41.1	41.4	2.6	0.4	3.0
Watershed	342.2	352.6	371.0	10.4	18.5	28.8

Long Island Sound Watershed's Changing Landscape Project

A 2012 LISS-funded study by the University of Connecticut's Center for Land Use Education & Research (CLEAR) summarizes land cover changes for the lower LIS watershed study area from 1985 to 2010. The lower LIS watershed study area includes primarily CT and NY, an area comparable to what the TMDL defines as "in-basin." CLEAR data for land cover and riparian zone land cover change from 1985 to 2010 are shown in Figure 18. The web-based and interactive maps[3] developed for this project show distribution of these land cover changes throughout the lower watershed. Appendix D of the CTDEEP section of this report also provides land cover change data by HUC 8 watersheds (major basins). From 1985 to 2010, developed, impervious, and turf and grass land cover increased, while land cover categories related to agricultural production, forested land, and wetlands decreased. Like the NLCD indicators, these data indicate development in the watershed.

Although the CLEAR data indicate development in non-riparian and riparian areas, in most cases the degree of development appears to be less in riparian zones than in non-riparian areas, as shown in Figure 18. This may indicate that although the watershed is becoming more developed, development in riparian areas is limited, possibly due to regulations aimed to limit the impact of development on water quality.

Figure 18: Lower LIS watershed study area percent land cover (riparian and non-riparian) change, 1985-2010 (CLEAR, 2012) Note: No impervious cover data available for riparian zones



[3] "The Long Island Sound Watershed's Changing Landscape" website: http://clear.uconn.edu/projects/landscapeLIS/index.htm

Agricultural Land Cover & Land Use Indicators

NLCD and CLEAR data indicate that the watershed is becoming more developed and agricultural land cover is decreasing. Although the agricultural sector in the watershed appears to be in decline, nitrogen loading from agricultural lands largely depends on agricultural practices. Additional agricultural land cover and land use data and indicators are provided in the state sections to better explain how changes in the agricultural sector may be impacting nitrogen loading to the Sound. Table 2 summarizes the agricultural indicators presented in the state sections of this report.

Table 2: Summary of agricultural land cover and land use indicator data provided in the state sections

Indicators	**CT**	**MA**	**NH**	**NY**	**VT**
Data Source, Timeframe (unless otherwise noted)	USDA Census of Agriculture, 1987-2007	MA GIS Interpretation, 1985-2005[4]	USDA Census of Agriculture, 1992-2007	CLEAR LISS Land Cover Data, 1985-2010	USDA Census of Agriculture, 1987-2007
Commercial Fertilizer Spread	-38%	Not Provided	-25%	Not Provided	-32%
Manure Spread	Not Provided	Not Provided	-25% (2002-2007)	Not Provided	-10% (2002-2007)
Number of Farms	+37%	Not Provided	+68%	Not Provided	Not Provided
Farm Acres	+2%	-29%	+28%	Not Provided	-8%
Agricultural Field (CLEAR, 1985-2010)	-1.3% (-0.8% riparian)	Not Provided	Not Provided	0%	Not Provided
Cropland	Not Provided	Not Provided	-7%	Not Provided	-25%
Other Agricultural Uses	Not Provided	Not Provided	-14%	Not Provided	Not Provided
Pasture	Not Provided	Not Provided	+259%	Not Provided	Not Provided
Woodland	Not Provided	Not Provided	+47%	Not Provided	Not Provided
Total Farm Animals (all listed below)	Not Provided	Not Provided	-17%	Not Provided	Not Provided

[4] Massachusetts GIS interpretation from orthophotos of land surface in earlier period (1985) compared with satellite imagery in more recent period (2005).

Indicators	CT	MA	NH	NY	VT
Cattle (Population)	-44%	Not Provided	-21%	Not Provided	-23%
Swine (Population)	-33%	Not Provided	-23%	Not Provided	-34%
Sheep/lamb (Population)	Not Provided	Not Provided	-19%	Not Provided	-28%
Equine (Population)	Not Provided	Not Provided	+78% (1997-2007)	Not Provided	Not Provided

Despite gaps in data from state to state, these indicators further confirm a decreasing trend in the agricultural sector watershed-wide. While the number of farms appears to be increasing, farm and cropland acres are generally decreasing. Where farm acres have increased, the majority of the acreage increase is classified as woodland. For example, farm acres in NH increased by 28% from 1992 to 2007, but 89.5% of that increase is land classified as woodland. Furthermore, while indicators suggest that agricultural land classified as pasture has increased significantly (259% in NH), total farm populations show significant decreases in CT, NH, and VT. In trends related to agricultural management practices, commercial fertilizer spread has decreased since 1987 and 1992, and manure spread has decreased since 2002. Due to the decline in the agricultural sector, it is likely agricultural sources of nitrogen have also decreased relative to nitrogen loading from stormwater and nonpoint source runoff from developed lands.

Changes in Drivers of Nitrogen Loading

The LIS watershed has undergone significant development since 1990. Developed land and impervious cover have increased considerably since the TMDL baseline, and that trend has likely driven greater nitrogen loading from stormwater and urban runoff. Increases in turf and grass land cover (also an indicator of development) suggest increased drivers of nitrogen loading from fertilizer and other turf management practices. Decreases in forested land and wetlands indicate less nitrogen storage throughout the watershed, further driving nitrogen loading transported by rivers and streams to the Sound. Finally, population growth and increased use of decentralized wastewater (i.e., septic systems) to manage sanitary waste indicate significant increases in nitrogen loading, especially along tributaries and in coastal areas. These data all point to an increase in drivers of nitrogen loading to the Sound from development. Water quality management programs, many of which were initiated after 1990, may mitigate to some extent this increase and overall nitrogen loading to the Sound.

On-the-Ground Nitrogen Control Efforts

This section of the report summarizes on-the-ground nonpoint source and stormwater nitrogen control efforts as reported for the five watershed states and the watershed as a whole. The changes in scope (diversity and coverage of nitrogen management programs) and effectiveness (expected nitrogen removal and environmental benefits) of on-the-ground nitrogen control efforts since 1990 serve as a measure of TMDL implementation. The TMDL LAs require a 10% watershed-wide reduction in nitrogen from nonpoint sources and stormwater. This section first summarizes watershed-wide efforts and developed land and agricultural land practices by state. The impact of watershed development on the effectiveness of TMDL implementation is then discussed.

Watershed-Wide Efforts

A number of regional and national efforts support nitrogen management and removal within the LIS watershed. These efforts include federal regulation, voluntary initiatives, and research.

Atmospheric Reductions

The substantial reductions in atmospheric sources of nitrogen previously discussed are largely attributed to regional and national efforts to restrict nitrogen oxide (NOx) emissions from vehicles and electricity generation. The Clean Air Act Amendments of 1990 (CAAA) represented the first real national attempt to control NOx emissions from stationary sources. Since the recognition of the impact of NOx emissions on ozone control, Title I of the Act was amended to require reasonably available control technology (RACT) in ozone nonattainment areas and in the newly formed ozone transport region (OTR). The primary result of the RACT requirement was for major sources of NOx emissions in nonattainment areas and the OTR to use basic low-NOx combustion control technology.

Stemming from these measures, EPA and states in the Northeast identified the need for deeper NOx reductions to attain the ozone standard. By 2004, all affected states were participating in the regional summertime NOx Budget Trading Program, and reductions from large electricity generating units (EGUs) and other large stationary sources of NOx were required. While these actions were widely praised for their effectiveness, one shortfall was that the trading program was based on the 1979 ozone National Ambient Air Quality Standards (NAAQS). In 1997, EPA had adopted a more stringent NAAQS for ozone and particulate matter. To update the established trading program and required NOx reductions to reflect the 1997 NAAQS, the regional Clean Air Interstate Rule (CAIR) was adopted in 2005, with Phase I going into effect in 2009 and Phase II in effect in 2015.

Fertilizer Initiatives in the Region

A number of regional, state, and local efforts have been undertaken to reduce the impact on water quality of nutrients associated with fertilizer use. At the regional level, the Northeast Voluntary Turf Fertilizer Initiative engaged the six New England states and New York State, EPA, and industry and non-industry stakeholders in a collaborative effort to discuss and address the contribution of turf-applied fertilizers to polluted runoff and the resulting water quality problems, including low dissolved oxygen in water bodies such as Long Island Sound. Working with its state and federal partners, NEIWPCC coordinated a series of issue-specific meetings with various stakeholders as part of a process that resulted in the development of mutually agreeable and scientifically sound regional guidelines on the formulation and application of turf fertilizer.[5]

The list below highlights milestones in the Northeast Voluntary Turf Fertilizer Initiative and other notable regional, state, and local efforts to address the water quality impacts of fertilizer use. Fertilizer-related legislation is summarized by state in the appendix.

- January 2009 – Suffolk County (NY) ordinance limiting turf fertilizer use goes into effect. Extensive press coverage fuels interest in the contribution of turf fertilizer to water quality problems throughout the region.
- Fall 2009 – NEIWPCC's Nonpoint Source Pollution Workgroup first discusses pursuing a source-control project. NEIWPCC begins compiling information about state laws related to turf fertilizer and phosphate in dishwasher detergent.
- August 2010 – New York State becomes the first NEIWPCC member state to pass a statewide environmental law restricting the use of turf fertilizer, for the benefit of water quality. The law does not restrict nitrogen content or use specifically. Other states take notice.
- May 2011 – The New England state environmental commissioners formally propose a regional voluntary approach to reducing impacts of turf fertilizer on water quality and ask NEIWPCC to coordinate the effort. Vermont becomes the second NEIWPCC member state (and first state in New England) to pass a statewide law and the first to specifically address nitrogen (requiring at least 15% slow-release nitrogen in turf fertilizer products).
- September 2011 – The New England state environmental commissioners sign a formal statement of intent supporting the regional voluntary initiative.
- Fall 2011-Spring 2012 – NEIWPCC works with state and EPA technical staff to synthesize existing laws and technical guidance documents into a draft set of guidelines for the formulation and labeling of turf fertilizer products.
- May 2012 – NEIWPCC hosts the first regional stakeholder meetings, which focus on formulation and labeling issues. The primary participants are fertilizer manufacturers and associated trade groups.
- June 2012 – Connecticut passes a state fertilizer law. The law does not restrict nitrogen content or use specifically but is the first of its kind to extend restrictions related to phosphorus to compost.

[5] The Northeast Voluntary Turf Fertilizer Initiative webpage: http://neiwpcc.org/turffertilizer/guidelines.asp

- July 2012 – NEIWPCC issues summaries of the May meetings and begins considering revisions of the draft formulation and labeling guidelines, based on input received at the meetings.
- August 2012 – Massachusetts passes a state fertilizer law. The law does not specifically address nitrogen but assigns the state's Department of Agricultural Resources to work with MassDEP to develop regulations, which may address nitrogen pollution.
- September 2012 – The regional initiative is discussed at NEIWPCC's Commission meeting and a subsequent meeting of the New England environmental agency commissioners. It is decided that the regional approach should not exempt organic products, to remain consistent with the NY and CT laws.
- Fall 2012-Spring 2013 – NEIWPCC works with state and EPA technical staff to synthesize existing laws, technical guidance documents, and comments received at the May 2012 meetings into a new draft set of guidelines for the application/use of turf fertilizer products.
- March 2013 – NEIWPCC hosts a second set of stakeholder meetings, focusing this time on application behavior and outreach issues. The meetings attract a broad range of participants, including lawn care professionals and associated trade groups, university extension programs, fertilizer manufacturers, golf course superintendents and associated trade groups, watershed groups and other NGOs.
- June 2013 – New Hampshire passes legislation that includes limits on the total and soluble nitrogen and available phosphorus content of residential turf fertilizer sold at retail outlets.
- January 2014 – NEIWPCC completed a final report to the New England and New York State Environmental Agency Commissioners: *Regional Clean Water Guidelines for Fertilization of Urban Turf*.

USDA NRCS Conservation Program in the LIS Watershed

The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) administers conservation programs offering financial and technical assistance to implement agricultural BMPs, many of which result in nitrogen removal. Participation in these programs is voluntary, and interested clients (i.e., land owners) apply for funding in consultation with their local NRCS Conservation Planner. The scope and effectiveness of NRCS BMPs in the states in the LIS watershed are summarized below in the "Agricultural Lands" section of this report. Recently, NRCS headquarters designated a Landscape Scale Conservation Partnership for the LIS watershed region, which will increase the impact and efficiency of the NRCS programs already in place in the watershed.

Optimizing Nitrogen Removal from Stormwater Treatment Systems

In December 2010, EPA Region 1 (New England) contracted with the University of New Hampshire Stormwater Center (UNHSC) to conduct a two-year research project on optimizing nitrogen removal from stormwater treatment systems. Excess nitrogen loading causes impairment to not only Long Island

Sound, but many other water bodies in the Northeast including Narragansett Bay (RI and MA), Buzzards and Cape Cod Bays (MA), and Great Bay (NH), and in almost every case, stormwater is a significant contributor to the problem. As of the publication of this report, UNHSC is in the midst of the first year of the project, in which existing stormwater BMP total nitrogen removal efficiencies are being assessed across the range of annual climate conditions. Concurrently, UNHSC is conducting laboratory column studies to test various filter media combinations to optimize nitrogen removal. In the second year of the project, promising media blends will be used in field tests at two constructed bioretention cell BMPs and tested over the course of the year to measure nitrogen removal efficiencies, identify opportunities for further optimization, and assess widespread applicability.

Bioretention-Based Stormwater Practices for Nitrogen Removal: Implementation and Monitoring

In October 2012, a LISS-funded UConn CLEAR project began to install bioretention-based stormwater BMPs for nitrogen removal in urbanized communities within the TMDL area. The work will be completed in cooperation with CTDEEP, EPA Region 1, and UNHSC. BMP implementation and installation involves the construction of a bioretention cell to accommodate runoff from a 3,000 square foot UConn parking lot to treat 79,000 gallons of runoff annually. The planned outcome of this project is twofold: (1) implementation of these BMPs will result in nitrogen removal, and (2) the efficiency of nitrogen removal will be documented to improve future designs for bioretention BMPs.

Systematic Evaluation of Nitrogen Removal by BMPs in the Long Island Sound Watershed

In 2011, a LISS-funded study began to investigate the effectiveness of stormwater BMPs, specifically constructed wetlands and retention basins, in removing nitrogen. In evaluating the efficiency of these BMPs, the project will construct water and nitrogen budgets for a number of representative ponds and wetlands to evaluate success in nitrogen removal. Nitrogen concentrations and uptake will be measured, along with parameters that might affect BMP efficiency, such as water temperature, water residence time, soil characteristics, and vegetative cover. The goal of this study is to measure the effectiveness of the BMPs and identify the conditions under which they will most effectively remove nitrogen. The findings of this study will be used to improve future BMP design to effectively remove nitrogen and improve water quality and estuarine health.

Nitrogen Management Practices by State

The five LIS watershed states have discussed and implemented a range of programs and practices intended to mitigate or prevent nitrogen pollution. Some of these efforts are a result of regulation or permitting processes, others are motivated by incentive, and some are simply voluntary actions. Regardless of the motivation, the efforts reduce nitrogen load stressors through nonpoint source and stormwater treatment or runoff reduction, which likely reduces nitrogen loading to the Sound. **By evaluating the varying parameters used by each state, data and information gaps may be identified and data and tool improvements may be recommended on a watershed level to allow for quantitative TMDL evaluations.**

The following sections summarize the qualitative assessment completed by each of the five watershed states as reported in the state sections of this report. The summary is based on the qualitative (and quantitative when available) parameters and outcomes used to measure the scope and effectiveness of nitrogen control programs for developed and agricultural lands. The developed lands summary is presented first, followed by the agricultural lands summary, and finally the scope and effectiveness of these programs are discussed as a measure of TMDL LAs at the watershed level. Further details on the regulatory programs of each state in the watershed are provided in the appendix.

Parameters reported vary from state to state based on the information readily available. Gaps in the information provided by one state versus another are data tracking gaps and do not necessarily indicate gaps in the state or federal programs. Furthermore, while this is a fairly comprehensive summary of the state sections, there may be aspects of the state sections that are not specifically addressed. More detail on the state approaches and findings for this report can be found in the state sections.

Developed Lands Nitrogen Management Practices

Connecticut Developed Lands

Connecticut discussed the scope and effectiveness of urban nonpoint source (NPS) and stormwater nitrogen management programs through the following select parameters and associated outcomes:

Parameter	Outcome
Effectiveness of the Industrial Stormwater Permit Program based on data analysis exercise conducted by CTDEEP using data submitted as required by the permit	Since 1995: A 39% and 9% reduction in NO_3 and TKN, respectively in the 50th percentile; and a 50% and 29% reduction in NO_3 and TKN, respectively in the 95th percentile. See Connecticut Figure 1: Graph of Industrial Stormwater NO_3 and TKN data, 50th percentile; and Figure 2: Graph of Industrial Stormwater NO_3 and TKN data, 95th percentile.
Number of commercial and industrial facilities, construction sites, and municipalities operating under the stormwater permit program, 1990-2012	1990-2012: More than 2,000 commercial and industrial facilities, construction sites, and municipalities have operated under stormwater general permits, requiring the implementation of stormwater pollution reduction practices. See Connecticut Figure 3: Stormwater Permits in Connecticut and Figure 4: Urbanized (MS4) Areas in Connecticut.
Efforts to minimize nitrogen loading from septic systems (this information is not inclusive)	<u>Fixing Known Problems</u>: Pine Grove Sewering Project area consists of 172 homes/35 acres; preliminary pre- and post-sewer nitrogen concentration data show decrease in nitrogen in shallow and mid-depth wells. Public sewer service has been extended into additional areas. However, an exact accounting of homes sewered is not available. <u>Use of Alternative Technologies</u>: Old Saybrook Decentralized Wastewater Management Program project will result in 360 upgraded conventional onsite wastewater systems by end of 2013.
Gallons of boat discharge (sewage) avoided under the Clean Vessel Act of 1992	105 marine facilities provide boat pump-out services of which 37 facilities reported collection of 619,735 gallons in 2010, 36 facilities reported collection of 517,952 gallons in 2011, and 41 facilities reported collection of 581,103 gallons in 2012 – equating to an estimated 1,489 pounds of nitrogen removed (data limited to facilities reporting).
Number of CSOs, elimination of CSOs, long-term control plans, secondary treatment	1990-2011: 6 of 13 CSO communities and 115 of 257 individual outfalls remain; 4 of the remaining 6 CSO communities are implementing long term control plans; 2 communities are implementing secondary treatment bypasses; since 1999, $137

bypasses, dollars expended, and future expenditures needed	million has been expended for long-term control plan design and implementation; $2.3 billion expected expenditures over next 20 years.
Number of Low Impact Development (LID) projects and towns adopting LID requirements	80 LID projects self-reported; 9 towns adopting LID requirements into zoning regulations as of 2008 (self-reported; likely incomplete).
Turf Management Program research (estimated acres and percentage/pound reduction of nitrogen)	UCONN Integrated Pest Management/Turf Management Program resulted in a 32% or 42,117 pound reduction of nitrogen over 376 acres in the Quinnipiac River Watershed.
Estimated nitrogen removal from Section 319 Grant Projects, 2003-2009	36 BMPs implemented with total nitrogen removal estimated to be 281,289 pounds per year. See Connecticut Table 6: Estimated Nitrogen Reductions from the GRTS Database.

Massachusetts Developed Lands

Massachusetts discussed the scope and effectiveness of urban NPS and stormwater nitrogen management programs through the following select parameters and associated outcomes:

Parameter		Outcome
Number and type of MS4 and non-MS4 community BMPs	➡	Survey results from 34 out of 38 MS4 and 15 out of 74 non-MS4 communities reported 296 BMPs in MS4 communities, 77 BMPs in non-MS4 communities, and 213 BMPs where nitrogen removal or control was able to be estimated. See Massachusetts Table 5: BMPs Reported by Communities and Table 6: MA Loading Reductions Associated with Urban BMPs.
Estimated nitrogen controlled by MassDOT BMPs and housekeeping activities	➡	Estimated total nitrogen controlled equals 44% of the 10% reduction required by the TMDL LA. See Massachusetts Table 12: Total Nitrogen (TN) Loading Reductions for Districts 1, 2, 3.
Estimated nitrogen controlled by all developed lands BMPs relative to the TMDL LA	➡	Total nitrogen controlled by MS4 communities, non-MS4 communities, and MassDOT BMPs is estimated to be 332% more than the 10% nitrogen reduction required by the TMDL LA.
Estimated nitrogen removal from Section 319 Grant Projects, 2003-2009	➡	5 BMPs implemented, with removal estimated to be 499 pounds per year. See Massachusetts Table 13: Massachusetts LIS Watershed 319 Projects with Estimated TN Reductions.
CSO regulators removed and estimated total nitrogen reductions	➡	79 out of 149 combined sewer regulators have been eliminated; estimated to result in 45,870 pounds of total nitrogen removed annually. See Massachusetts Table 14: Massachusetts LIS Watershed CSO Status, as of June 24, 2011.

New Hampshire Developed Lands

New Hampshire discussed the scope and effectiveness of urban NPS and stormwater nitrogen management programs through the following select parameters and associated outcomes:

Parameter	Outcome
Increase in activities requiring a NPDES Construction General Permit (CGP) for stormwater and/or Multi-Sector General Permits (MSGP)	2003: Coverage of Construction General Permit expanded from disturbance of 5 acres or more to 1 acre or more, thus expanding the number of activities required to mitigate stormwater runoff. Since 2000, approximately 100 industrial facilities have filed NOIs under the MSGP and have developed and implemented Stormwater Pollution Prevention Plans to minimize contamination in their stormwater discharges.
Number of CSOs eliminated, future plans for elimination, and estimated nitrogen removal to be achieved	4 out of 7 CSOs remain; all are to be separated and connected to secondary wastewater treatment by 2020, which may reduce the CSO total nitrogen load by an estimated 10-30%.
Number of Alteration of Terrain (AoT) Permits issued with treatment practices	1986-2012: Approximately 1,000 AoT permits issued; 422 permanent treatment practices implemented since 2004 (not tracked prior). For number of practices by type, see New Hampshire Table 3: BMPs Permitted by AoT in the Connecticut River Basin Since 2004.
Expanded scope of AoT regulations in 2009	2009: AoT regulations expanded to limit area of unstabilized soil and to require improved erosion and sediment control measures; improved permanent stormwater treatment and groundwater recharge; protection of channels, downstream receiving waters, and wetlands; peak run-off control; and long-term maintenance practices.
Expanded scope of Shoreland Water Quality Protection Act Program (SWQPA) by authority and number of permits processed	Since 2008: Processed approximately 652 SWQPA permits, which track associated water body, area, impervious surface change, area where alternative technologies are used, area of buffer restoration, and disturbed area.
Number and type of NH Department of Transportation (NHDOT) roadway BMPs implemented, 1983-2012	1983-2012: NHDOT implemented and maintained 4 underground BMPs, 3 constructed wetlands, and 5 dry detention basins, totaling 11 BMPs.

Number of Section 319 Grant Projects (1990-2012) and estimated nitrogen removal if available	1990-2012: 9 projects implemented; nitrogen removal available for two of the projects, totaling an estimated 27 pounds of nitrogen removed annually.
Number of Section 401 Water Quality Certifications (WQC) issued for development projects requiring pollutant load analyses	1990-2012: 3 WQCs issued that required pollutant loading analyses demonstrating no additional loading of total nitrogen, total phosphorus, and total suspended solids.

New York Developed Lands

New York discussed the scope and effectiveness of urban NPS and stormwater nitrogen management programs through the following select parameters and associated outcomes:

Parameter	Outcome
Department of Sanitation systematic street litter monitoring “Scorecard Program” of NYC street sweeping program	New York City-wide street litter levels have improved somewhat over the past six years with improvements in the percent acceptable and percent filthy ratings.
NYC catch basin SPDES compliance requirements	By 2008, all catch basins complied with the SPDES program through retrofit, repair, and reconstruction; 2011: 42,873 catch basin inspected, 31,957 cleaned, and 654 hooded.
Floatable containment and capture by drainage area acres, and cubic yards retrieved	2011: 24 NYCDEP floatable containment facilities maintained, covering 60,000 acres of MS4 drainage area; 1,990 cubic yards of floatable material retrieved.
Public education and outreach/involvement activities and clean-ups	2011: “Keep New York City Beautiful” activities ticketed 1,800 dog walkers, planted over 1 million trees, and constructed 312 Greenstreets.
NYCDEP harbor-wide water quality sampling data for DO	1970-2010: DO levels in the Upper East River and Western Long Island Sound show an upward trend; since 2005, both bottom and surface waters have averaged above NYS DO water quality standards.
Estimated effectiveness of the implementation of the six minimum control measures (MCM) under the NYSDEC MS4 permit program (See New York Figures 6-19)	MCM 1 – Public Education and Outreach: Implementation of education and outreach strategies increased from 93 to 99% between 2009 and 2011.
	MCM 2 – Public Involvement/Participation: Trends show public awareness increased through education and outreach, thus public participation has increased.
	MCM 3 – Illicit Discharge Detection and Elimination: 2009-2011: 85% of the MS4 communities have completed outfall mapping; 65% and 58% actively participated in Outfall Screening in 2010 and 2011, respectively; 2,785 and 2,367 outfalls screened in 2010 and 2011, respectively; 86% of MS4 communities have adopted an IDDE Law; 69% of MS4 communities completed sewershed

	mapping.
	MCM 4 – Construction Site Stormwater Runoff Control: Increase in the number of MS4s participating in the administrative duties, nearly all construction sites inspected each reporting period, and increase in contractors receiving construction site stormwater management education; changes led to decrease in construction permit violations .
	MCM 5 – Post-Construction Stormwater Control Measures: increase in post-construction stormwater management practices inspected, inventoried, and maintained for MS4s over three consecutive reporting periods.
	MCM 6 – Pollution Prevention/Good Housekeeping for Municipal Operations: 2009-2011 – 64% reduction in total nitrogen from municipal application of fertilizer; acres of parking lot sweeping operations increased eightfold and acres of street sweeping doubled.
Section 319/NYSDEC LIS Water Quality Improvement Projects funded	Since 1996: 115 projects totaling $193,661,265 in funding awarded. See New York Table 9: Long Island Sound Water Quality Improvement Projects.
LIS Futures Fund (LISFF) projects for NPS and stormwater pollution controls	2005-2012: 126 projects totaling $5,007,106 in funding awarded. See New York Table 10: Long Island Sound Futures Fund Projects.
Expansion of SPDES General Permit for Stormwater Discharges from MS4 communities	2003: Addition of the six minimum control measures (above); coverage of non-traditional MS4s; select annual reporting requirements; appendices of impaired stream segments and TMDL watersheds; watershed improvement strategies; and Stormwater Pollution Prevention Plans (SWPPP).
Number of CSOs remaining	1993-2009: CSO outfalls decreased from 1,300 to less than 1,000.

Vermont Developed Lands

Vermont discussed the scope and effectiveness of urban NPS and stormwater nitrogen management programs through the following select parameters and associated outcomes:

Parameter	Outcome
Acres of impervious surface permitted under the post-construction stormwater permit	1,307 acres of impervious surface actively permitted under the post-construction stormwater permit.
Illicit discharges detected, corrected, and nitrogen loading eliminated	City of Brattleboro Illicit Discharge Detection and Elimination (IDDE) Project assessed 300 structures and detected 6 illicit discharges; to date, 2 have been resolved, one of which eliminated an estimated 224 kg of nitrogen during a 30-day period of discharge. Several other towns are at various stages of the process including stormwater infrastructure mapping and discharge detection or elimination.
Water Quality Remediation Plans for stormwater impaired ski areas	Four watersheds covering an area of 4,563 acres will receive extensive stormwater retrofits to reduce local stream impairment from ski area development (a TMDL alternative).
Scope of Vermont Agency of Transportation (VTrans) stormwater programs and partnerships	VTrans staff includes specialists in federal stormwater regulations, vegetation management, erosion control, riparian restoration and management, construction environmental engineering, and environmental policy and planning; and provides ongoing water quality training for designers, contractors, and staff. VTrans partners with VTANR, municipalities, and watershed organizations.
VTrans financial investments in water quality protection	Municipal Town Highway Grants offer $13.8 million in state funds annually; Town Highway Aid offers $25 million in state funds annually; Transportation Enhancement Program offers $3 million in federal funds annually; FEMA Public Assistance Program offered $29.5 million in mixed funding over past 10 years; and administration of the Federal Municipal Highway Stormwater Mitigation Grant Program is offering $5.4 million over 5 years (2007-2011).
Better Back Roads Program cumulative road inventories and erosion control projects and project costs	2004-2012: Better Back Roads Program completed 28 road inventories at a cost of $95,593 and has undertaken 144 erosion control projects at a cost of $1,022,490. See Vermont Figures 14-17.

Number of Section 319 Grant Projects and financial assistance provided	Since 1997: Section 319 Grants have funded 33 projects with financial assistance, totaling $669,334. See Vermont Table 5: Vermont §319 Grants Awarded within the CT River Basin.
Ecosystem Restoration Program projects awarded funding	Since 2006: Vermont's Ecosystem Restoration Grant Program awarded funding to 63 projects, providing $1.8 million: $713,416 to conservation easements, $762,263 to development projects, and $346,651 to implementation projects. See Vermont Table 6: Ecosystem Restoration Grant Program Project Funding Awarded in the CT River Basin.

Agricultural Lands Nitrogen Management Practices

Connecticut Agricultural Lands

Connecticut discussed the scope and effectiveness of agricultural NPS nitrogen management programs through the following select parameters and associated outcomes:

Parameter		Outcome
BMPs implemented with NRCS Conservation Program assistance	→	2004-2011: NRCS practices implemented 24,332 acres of erosion and control practices; 25,630 acres of nonpoint source practices; and 9,728 acres of nutrient management practices.
Nutrient Management Plans completed	→	Since 1990: 269 Nutrient Management Plans approved for adequate storage of manure and wastewater; clean water diverted from production areas; land application of manure and wastewater; management of dead animals; and recordkeeping to document implementation.
Local, state, federal partnership across environmental and agricultural programs for technical and financial assistance to farmers	→	Since 1990: Partnership for Assistance on Agricultural Waste Management Systems and the Environmental Assistance Program (to supplement NRCS resources) provided assistance to farm businesses in waste management planning, structure design, and how to qualify for financial assistance as well as offered help in procuring required permits.
Connecticut Department of Agriculture Bureau of Aquaculture sanitary surveys	→	Conduct shoreline surveys to protect CT's shellfish resources and also to detect nitrogen pollution sources, including improperly functioning septic systems, illicit sanitary discharges, and failures in the sanitary sewer conveyance system.

Massachusetts Agricultural Lands

Massachusetts discussed the scope and effectiveness of agricultural NPS nitrogen management programs through the following select parameters and associated outcomes:

Parameter		Outcome
BMPs implemented with NRCS Conservation Program support	→	2008-2011: 2,225 NRCS BMPs implemented over 20,334 acres. See Massachusetts Table 7: NRCS Total Nitrogen (TN) Reductions by BMP and Watershed.
State programs supporting/supplementing NRCS programs	→	Massachusetts Department of Agricultural Resources (MDAR) provides education and outreach to support the NRCS EPICS program. Since 2009: 20 BMP projects over 4,625 acres. See Massachusetts Table 8: Recent Farm Related MA Department of Agricultural Resources BMP Projects.
Estimated nitrogen controlled by agricultural practices relative to TMDL targets	→	Nitrogen control from NRCS practices + state implemented practices = ~50% of the 10% load reduction target defined in the 2000 TMDL.

New Hampshire Agricultural Lands

New Hampshire discussed the scope and effectiveness of agricultural NPS nitrogen management programs through the following select parameters and associated outcomes:

Parameter		Outcome
BMPs implemented with NRCS Conservation Program support	→	2003-2011: NRCS-supported BMPs include 33 waste storage facilities, 5 compost facilities, 89 acres of conservation cover, 2,025 acres of cover crop, 50 acres of field border, 2 acres of riparian herbaceous cover, 48 acres of riparian forest buffer, and 1,519 acres of prescribed grazing. See New Hampshire Table 6: USDA NRCS Agricultural BMP Statistics by Towns (2003-2011).
New Hampshire Department of Agriculture (NHDA) Division of Regulatory Services' Agricultural Nutrient Management Grant Program	→	2002-2012: Provided 69 grants, totaling $156,862, to agricultural land and livestock owners as well as technical assistance and public education/outreach to mitigate/prevent nutrient pollution from commercial fertilizers, manure, and agricultural composts from adversely impacting surface waters. See New Hampshire Figure 21: NHDA Agricultural Nutrient Management Awards (2002-2012).

New York Agricultural Lands

New York discussed the scope and effectiveness of agricultural NPS nitrogen management programs through the following select parameters and associated outcomes:

Parameter	Outcome
Programmatic scope of NRCS Environmental Quality Initiative Program (EQIP)	Agricultural Management Assistance supports irrigation management and high-tunnel agricultural systems; Conservation Activity Plans address nutrient management; Conservation Innovation Grants stimulate development and adoption of innovative conservation approaches and technologies and leverage federal investment in environmental enhancement and protection, in conjunction with agricultural production.
Programmatic scope of NYS Agricultural Environmental Management (AEM) Program	Integration: Initiative to implement New York's Agricultural Nonpoint Source Abatement, Control Grant Program, and the Conservation Reserve Enhancement Program (CREP) integrating the New York State Soil and Water Conservation Committee and the New York State Department of Agriculture and Markets. Assistance: Provide technical and financial assistance to address environmental and nonpoint source issues on farms through assessment of practices, developing management plans, BMP implementation, and evaluation of environmental improvements. Program Support: Federal Farm Bill programs, Concentrated Animal Feeding Operations (CAFO), and the AEM Certification Program, which certifies public and private sector professionals as Comprehensive Nutrient Management Planners and provides a foundation for the NYSDEC CAFO Permit Program.

Vermont Agricultural Lands

Vermont discussed the scope and effectiveness of agricultural NPS nitrogen management programs through the following select parameters and associated outcomes:

Parameter	Outcome
Programmatic scope of local, state, and federal programs	Vermont Agency of Agriculture, Food and Markets (VAAFM) programs (see Vermont pg. 23 for details on assistance offerings): • Alternative Manure Management Program (AMM) • Best Management Practices Program (BMP) • Conservation Reserve Enhancement Program (CREP) • Farm Agronomic Practices Program (FAP) • Nutrient Management Incentive Grant Program (NMPIG) • Vermont Agricultural Buffer Program (VABP) Local Government Programs (see Vermont pg. 25 for details on assistance offerings): • Agricultural Resource Specialist Program (ARS) • Accepted Agricultural Practices Assistance (AAPA) • Agricultural Environmental Management (AEM) • Farm Well Water Testing (FWWT) • Land Treatment Planners (LTP) Federal Programs (see Vermont pg. 25 for details on assistance offerings): • Agricultural Management Assistance (AMA) program • Conservation Reserve Program (CRP) • Conservation Stewardship Program (CSP) • Environmental Quality Incentives Program (EQIP) • Farm and Ranch Lands Protection Program (FRPP) • Grassland Reserve Program (GRP) • Partners for Fish and Wildlife Habitat Restoration Program (PFW) • Watershed and River Basin Planning and Installation - Public Law 83-566 (PL566) • Wetlands Reserve Program (WRP) • Wildlife Habitat Incentive Program (WHIP) Additional Programs (see Vermont pg. 29 for details on assistance offerings): • Farmland Access Program (FAP) • Farmland Preservation Program (FPP) • Technical Assistance Programs (TAP) through Northeast Organic Farming Association

VAAFM BMP and Farm Agronomic Practices (FAP) Programs	→	1997-2013: 291 BMPs implemented under the BMP and FAP programs with $5.6 million in funding provided. See Vermont Figures 18 and 19 (Cumulative BMP projects implemented since 1997 [and cumulative project costs] in the Connecticut River basin in Vermont as part of the VAAFM BMP and FAP programs).

The Scope & Effectiveness of TMDL Implementation

This section evaluates the scope and effectiveness of state and watershed-wide TMDL implementation efforts relative to TMDL LAs for nonpoint sources and stormwater. TMDL LAs are assigned to in-basin (CT, NY, and LIS surface waters) and upper basin (MA, NH, VT) sources. The TMDL requires a 58.5% reduction to be achieved by 2014 of all anthropogenic nitrogen loading generated in-basin. After assigning a 10% reduction in nonpoint sources, WLAs were assigned to Connecticut and New York WWTPs to cover the remaining portion of the 58.5% total reduction required. The TMDL requires a 25% reduction from upper basin point source loads and a 10% reduction in upper basin nonpoint source loads. The TMDL also estimates an 18% reduction in atmospheric deposition of nitrogen throughout the watershed from Clean Air Act implementation. Because this evaluation is based on TMDL LAs, this section of the report discusses the scope of effectiveness of nitrogen management for in-basin, upper, and atmospheric deposition sources.

Has the in-basin nonpoint source and stormwater nitrogen load decreased by 10%?

Since the 1990 TMDL baseline, the watershed has developed. According to NLCD, the most significant increases in developed land, impervious cover, and population occurred in-basin (2001-2006). Development likely indicates increased drivers of nitrogen loading from developed lands runoff, stormwater, and wastewater loading to septic systems. Although development has increased significantly, a number of regulatory and non-regulatory programs have also been implemented and/or expanded in scope since 1990 that may result in nitrogen reductions. The full scope of these programs is discussed in detail in the CTDEEP and NYSDEC state summaries, and regulatory programs are summarized in the appendix of this report.

Addressing stormwater pollution from developed lands specifically, the municipal separate storm sewer system (MS4) permitting program was implemented in both Connecticut and New York in 1990, covering communities with populations greater than 100,000. It was expanded around 2000 to cover communities with a population less than 100,000. MS4-permitted communities are required to mitigate stormwater pollution prior to discharge to a water body. The MS4 permit program now covers 67% of communities in CT and 100% of communities in NY within the LIS watershed. Connecticut's regulated stormwater permit programs (first issued in 1992) require mitigation of stormwater pollution associated with industrial, commercial, and construction activities. Since 1990, New York State also manages a regulated stormwater permit program for construction and industrial activities. Both state permit programs call for increasing control requirements into their permit revisions at regular intervals.

As an example of the success of these regulatory programs, CTDEEP's industrial stormwater database (1995-2011) shows that in stormwater containing high concentrations of nitrogen, nitrate (NO_3) and total Kjeldahl nitrogen (TKN) have been reduced by 50% and 29%, respectively (CTDEEP, p. 6). Additionally, the entire New York State portion of the watershed is MS4-regulated, and NYSDEC believes compliance with the six minimum control measures of the general MS4 permit can result in a roughly 10% reduction in nitrogen loading delivered by nonpoint sources to the Sound (NYSDEC, p. 32). However, no technical analysis has been conducted to support that assertion. Other in-basin regulatory programs aim to address nitrogen impacts associated with combined sewer overflows, septic systems, wetland degradation, underground injection, fertilizer, agricultural runoff, and concentrated animal feeding operations.

The increase in scope of agricultural nitrogen management programs and the decrease in the agricultural sector suggest a decrease in nitrogen loads from agricultural lands to the Sound. In CT, between 2004 and 2011, 24,331 acres of erosion and control practices, 25,630 acres of nonpoint source practices, and 9,728 acres of nutrient management practices have been implemented with NRCS support. Connecticut has also approved 269 Nutrient Management Plans for agricultural landowners. These NRCS agricultural nutrient management programs are also actively implemented in NY, and the New York State Agricultural Environmental Management Program provides technical and financial assistance to address nonpoint source pollution issues with agricultural landowners. In addition to the increase in scope of agricultural nitrogen management programs, the agricultural sector has decreased in-basin. CLEAR data show that agricultural field land cover decreased in-basin by 1.1% (-41,233 acres) from 1985 to 2010. USDA Census of Agriculture data for CT from 1987 to 2007 show a 38% decrease in commercial fertilizer spread, a 44% decrease in cattle population (-60,263 cattle), and a 33% decrease in swine population (-1,784 swine). Therefore, it is likely that nitrogen loading from agricultural lands has decreased and that agricultural lands have likely been converted to developed lands.

CTDEEP and NYSDEC both conclude that progress has been made toward achieving in-basin load allocations for nonpoint source and regulated stormwater due to the enhancement of regulatory programs since 1990. They also agree that nitrogen loading from agricultural lands has likely decreased in magnitude relative to nitrogen loading from developed lands. However, determining that existing programs are adequate to reduce the nonpoint source and stormwater nitrogen load by 10% (TMDL LA) requires further analysis, given some nitrogen stressors—population, developed land, and impervious surfaces—have increased.

Has the upper basin nonpoint source and stormwater nitrogen load decreased by 10%?

Like the in-basin portion of the watershed, the upper basin of the watershed, including MA, NH, and VT, has also developed, but to a lesser degree. According to the NLCD, developed land, impervious cover, and population have all increased in the upper basin, and forested land has decreased (2001-2006). This same database shows some increase in agricultural lands. However, USDA Farm Census Data since 1987 for VT and since 1992 for NH show shifts in the agricultural sector that would suggest decreased drivers in nitrogen loading from agricultural lands. For example, commercial fertilizer usage decreased by 32% in VT since 1987 and 25% in NH since 1992, which would result in less nitrogen loading from agricultural fertilizers (VTDEC, p. 43-44, and NHDES, p. 49). Also, cattle populations decreased by 23% (-15,421 cattle) in VT since 1987 and by 21% (-3,057 cattle) in NH since 1992, which would result in reduced nitrogen loading from animal waste and associated activities, such as row crop production and fertilizer importation. Drivers of nitrogen from developed land and agricultural land have likely changed but to a lesser degree than in-basin. Therefore, this section focuses on the scope and effectiveness of developed and agricultural lands management programs in evaluating the TMDL LA for the upper basin. Further detail on these programs can be found in the state sections, and each state's regulatory programs are summarized in the appendix.

Under the National Pollutant Discharge Elimination System (NPDES) permit program, all upper basin states require mitigation of stormwater pollution from MS4 communities and industrial and construction activities. Additionally, Vermont's operational or post-construction permit program requires ongoing stormwater mitigation efforts for projects creating more than one acre in impervious cover (individual permits required for impaired water bodies). NHDES has two unique permit programs in place: (1) the AoT permit program, which requires permanent best management practices and temporary erosion and sediment control during construction to specifically protect surface water quality for projects that disturb more than 100,000 square feet (or less if any portion of the project is within a protected shoreland or has a grade of 25% or greater within 50 feet of a surface water) and (2) the Shoreland Water Quality Protection Act permit program, which limits shoreland development to protect shoreland integrity for water quality. MA has the Rivers Protection Act, which prohibits new riverfront development within 200 feet of a riverbank.

MA is the only upper basin state with MS4 communities located within the watershed (38 Phase II or small MS4 permittees). In an attempt to measure the scope and effectiveness of regulatory and non-regulatory stormwater nitrogen control efforts on developed lands, MassDEP conducted an MS4 and non-MS4 community survey to collect data regarding nonpoint source and stormwater implementation efforts that may result in nitrogen removal. Methods for conducting this survey and the results are explained in detail in the MassDEP state section of this report (MassDEP, p. 25-30). MassDEP applied nitrogen removal values for each practice reported to conduct a preliminary quantitative evaluation of nitrogen removal in the LIS watershed. Based on these surveys and BMPs reported through other programs, MassDEP estimated nitrogen reductions from developed lands BMPs. The mass of nitrogen estimated to be controlled by these practices was more than three times the reduction necessary to attain the load allocation (MassDEP, p. 30). Because no data are available to compare current levels of implementation of these practices to levels corresponding to the baseline load, no conclusion can be drawn on whether nitrogen control estimates represent a *reduction* from baseline levels. Although data gaps prevent these values from being used for a complete watershed TMDL evaluation, the MassDEP approach provides insight to data collection and calculation needs and offers considerations for quantitative TMDL evaluations watershed-wide.

MassDEP also quantitatively estimated nitrogen removal from NRCS and state-implemented agricultural BMPs. In doing so, MassDEP found that approximately half of the 10% nitrogen reduction required by the TMDL LA was achieved for agricultural lands (MassDEP, p. 36). However, according to the New England SPARROW model, the majority (excluding atmospheric deposition) of the nitrogen load from VT and NH (21% and 16%) is from agricultural lands, while agricultural lands make up the smallest portion (10%) of MA's nitrogen load (2004). Given nitrogen loading from agricultural lands is most significant in VT and NH, the scope of agricultural management programs for water quality improvements has increased significantly in these states since the early 1990s. In VT, 20 of the 21 state and federal programs addressing agricultural impacts on water quality were initiated since 1990 (VTDEC, p. 44). Since the New Hampshire Department of Agriculture began administering the Agricultural Nutrient Management program in 2001, 69 Agricultural Nutrient Management program projects have been implemented in the LIS watershed (NHDES, p. 49). Both VT and NH offer technical assistance or guidance to farmers for implementing agricultural best management practices (BMPs) through guidance documents or cooperative extension programs. Watershed-wide, the USDA NRCS offers assistance and administers funding for a range of agricultural BMPs that may retain or remove nitrogen from agricultural lands. Based on the decline in the agricultural sector coupled with the increase in scope of agricultural lands management programs, VTDEC and NHDES both expect that agricultural nitrogen load reductions amount to the 10% reduction required by the TMDL.

Like the in-basin states, the upper basin states determined that they are on target towards meeting the TMDL LAs due to the increase in scope of regulatory and non-regulatory nonpoint source and stormwater nitrogen control efforts. Still, further quantitative analyses on the effectiveness of these programs are necessary before such conclusions can be definitively drawn.

Has the nitrogen load from atmospheric deposition decreased by 18%?

The TMDL anticipated that an 18% reduction in atmospheric sources of nitrogen would be achieved based on CAA implementation that would reduce nitrogen loading to the Sound by 1,524 tons per year. Even more aggressive reductions in atmospheric nitrogen, approaching 50%, would reduce nitrogen loading to the Sound by an additional 2,700 tons per year. According to National Atmospheric Deposition Program (NADP) data from monitoring sites within or near the LIS watershed, NO_3 in wet deposition and precipitation-weighted mean concentrations of nitrate have decreased by approximately 50% since 1990. The Clean Air Status and Trends Network (CASTNET) also measures deposition fluxes of nitrogen throughout the country, including sites in Connecticut and New Hampshire in the Long Island Sound watershed. The CASTNET 2011 Annual Report cites a 26% reduction in total nitrogen deposition (wet and dry, nitrate and ammonium) between 1990 and 2011 from East Coast monitoring reference sites. While the actual amounts of nitrogen deposition throughout the LIS watershed may vary from these two estimates, in combination they strongly suggest that implementation of the CAA achieved at least the 18% reduction estimated in the TMDL.

Has nitrogen loading to the Sound decreased and hypoxia improved?

Trends in nitrogen load delivered to the Sound from surface water, groundwater, wastewater, and atmospheric deposition serve as a measure for the success of TMDL implementation. Currently available trend estimates for nitrogen loading in LIS watershed surface waters show a decline in nitrogen delivered to the Sound since 1974. However, these trends show nitrogen loading has stabilized since 1999 despite a decrease in nitrogen load from WWTPs by 46% in CT and 22% in NY since 1995. This may suggest that nitrogen loading stressors from stormwater and nonpoint sources have increased in the watershed. Furthermore, nitrate concentrations in groundwater aquifers in Suffolk County, NY, have increased 40-200% (depending on depth) from 1987 to 2005. While the glacial moraine of Long Island favors groundwater recharge rather than surface runoff, the data suggest that in some areas the drivers contributing nitrogen may be exceeding management responses. These surface water and groundwater trends suggest that nitrogen loading to the Sound from nonpoint sources and stormwater has been flat or increasing in recent years.

As mentioned above, however, NADP and CASTNET data from 1990 to 2012 strongly suggest that the 18% atmospheric nitrogen deposition reduction expected from implementation of the CAAA of 1990 has been achieved. Assuming that atmospheric deposition still contributes an estimated 40.8% of the nonpoint source and stormwater nitrogen load to the Sound, atmospheric nitrogen reductions may also result in significant total nitrogen reductions from stormwater and nonpoint sources throughout the watershed. Further data and analysis are necessary to evaluate the attainment of TMDL LAs (specifically nonpoint source and stormwater) based on nitrogen trends.

The ultimate goal of the TMDL is to reduce nitrogen loading to LIS in order to achieve water quality standards for DO in LIS and subsequently mitigate hypoxia. Therefore, the occurrence of hypoxia in the Sound may serve as a measure of TMDL implementation effectiveness. However, while hypoxia in the Sound is linked to excessive nitrogen loading, using the occurrence of hypoxia as a TMDL measure is limited because hypoxia is influenced by other factors. Still, hypoxia trends offer insight to how nitrogen loading is influencing water quality in the Sound.

Water quality is monitored in LIS through a combination of ship cruises and moored buoys supported by the LISS. This effort results in the production of annual maps depicting the areal extent of hypoxia in LIS. Additional research conducted by academics and other stakeholders also contributes to the body of knowledge regarding hypoxia in LIS. To date, 26 years of water quality data constitute the long-term monitoring database. While the database has substantially contributed to our understanding of hypoxia and variability within the system, analyses have not revealed an upward trend in DO. Complicating factors due to climate variability, including increased water temperatures, changes in wind direction and speed, shifts in the timing of precipitation events, and alterations to major climatic controls (e.g., North Atlantic Oscillation), are likely impacting hypoxia in the Sound. Given these factors, it is encouraging to see that hypoxia in LIS has not worsened and the area of hypoxia has decreased from a pre-TMDL average of 208 square miles to a post-TMDL average of 176 square miles. Other conditions, such as internal loading, may continue to provide excess nitrogen and delay the system's response to nitrogen reduction methods. Consider, for example, what occurred in Mumford Cove in Groton, CT. In 1987, a WWTP discharge to the cove was discontinued due to an overabundance of macroalgae that was fouling residential beaches. Following the halt in the discharge, nutrient water column levels were reduced, and in 1999, eelgrass was found to have increased from 0% to 26% (Vaudrey, 2008). A 2006 aerial photograph showed eelgrass flourishing in Mumford Cove. This situation demonstrates that restoration following a reduction in nutrient loading is possible and that the ecosystem response is not immediate. Even in small systems, a lag time does exist.

Conclusions

An analysis of the state sections from a watershed perspective makes it abundantly clear that the scope of nitrogen management programs and resulting on-the-ground implementation efforts have increased significantly since the 1990 TMDL baseline. It is also likely that the anticipated atmospheric deposition reductions have been achieved. However, nitrogen loading has stabilized or increased in some tributaries. Improving effectiveness monitoring of TMDL implementation and the analysis of nitrogen trends and drivers of nitrogen loading would enhance TMDL implementation.

Data Gaps for TMDL Evaluations

The scope of nitrogen management efforts has increased since the 1990 TMDL baseline, based on the increase in number and diversity of programs and practices. However, a quantitative determination of the effectiveness of nitrogen control efforts cannot be made without additional data and information. Two approaches can be taken to more quantitatively determine the effectiveness of nitrogen management efforts: (1) direct assessment of nitrogen loads in tributaries and as delivered to LIS and (2) enhanced measurement of the efficiency of nitrogen removal from on-the-ground BMPs and nitrogen control programs implemented throughout the watershed. Both approaches work concurrently to provide a quantitative measure. Unfortunately, both approaches also are currently limited by data and information gaps. These gaps are outlined in the following sections.

Approach 1 – Direct Measurements

Available nitrogen load trend analyses for the LIS watershed provide some indication of changes in nitrogen loading to the Sound as a measure of the success of TMDL implementation. However, existing nitrogen trend analyses do not include the entire five-state watershed and do not provide information on the cause of the trends or changes in nitrogen sources such as changes in land use, land cover, precipitation, and in-stream flow. There is also a lack of ambient water quality monitoring data from Massachusetts, New Hampshire, and Vermont, which limits the ability to conduct a watershed-wide nitrogen load trend analysis. Furthermore, existing nitrogen load trend analyses are unable to measure the success of TMDL implementation specifically for nonpoint source and stormwater management. Data gaps limiting the use of nitrogen load trend analyses as a measure of the effectiveness of TMDL implementation are listed below, and options for addressing these data gaps are provided in the "Suggested Data and Tool Improvements" section of this report.

- **Lack of analysis on the correlation between land use/land cover changes and conversions in the watershed and changes in nitrogen sources and nitrogen loading and how such changes may mask the effectiveness of nitrogen control programs.** Using existing CLEAR and NLCD data and other indicators, this report discusses the expected influence of land cover changes on nitrogen loading to the Sound, but data gaps prohibit an actual correlation between changes in land cover and nitrogen loading to the Sound.

- **Limited analysis on the influence of changes in precipitation and in-stream flow on nitrogen load and concentration, as well as the effectiveness of nitrogen control efforts.** A recent USGS trend analysis (1999-2009) suggests nitrogen loading increased in some LIS tributaries, but the increase in load may be attributed to increased precipitation and in-stream flow. Increase in precipitation and in-stream flow would increase the volume of runoff, which may mask the effectiveness of nitrogen control efforts despite the increase in scope of programs. Additionally, with increased runoff volume, the nitrogen load from nonpoint sources and stormwater relative to point sources may change. Analyses of the in-stream data are planned to better explain the effectiveness of management efforts despite the variability in flow.

- **Lack of watershed-wide analysis of localized atmospheric nitrogen deposition driven by local vehicle emissions.** The NADP NTN and CASTNET monitoring sites within or near the LIS watershed are intended to capture national trends in atmospheric nitrogen deposition, but are not meant to capture local trends. Therefore, trends driven by local vehicle emissions since 1990 are not captured in these data.

- **Lack of ambient water quality monitoring data for nitrogen in the upper basin (MA, NH, and VT) limits analysis of watershed contributions of nitrogen delivered to LIS by tributary and state**. Estimates of the nitrogen contribution from the upper basin at the CT and MA state border can be made using the current monitoring network. However, the nitrogen load cannot be apportioned among MA, NH, and VT. Also, since VT and NH share the Connecticut River where it crosses the northern MA border, it is unknown how the respective contributions of VT and NH would be determined. Furthermore, lack of upper basin ambient water quality data for nitrogen may also limit the accuracy of water quality model estimates. For example, the New England SPARROW model estimates the nitrogen load for the Connecticut, Thames, and Housatonic Rivers by source type and state using ambient water quality monitoring data from Connecticut and LIS surface waters.

Approach 2 – Efficiency of Watershed BMPs

Although on-the-ground nitrogen control efforts are described throughout this report, a number of considerations limit the appraisal of these efforts relative to TMDL-required nitrogen reductions. Currently, there is not a consistent method for calculating nitrogen removed from nitrogen control efforts, nor a framework summing nitrogen removal at the watershed level. Even if a watershed tally could be achieved, site-specific information is necessary for a scientifically defensible calculation of nitrogen removal to support TMDL evaluations. In order to quantify nitrogen removal estimates for on-the-ground BMPs as a TMDL measure, a tracking and accounting system is planned to be developed and is a component of the TMDL Enhanced Implementation Plan. This tracking system will assist in evaluating attainment of LAs and WLAs (from regulated stormwater) by tracking and accounting for nitrogen control practices implemented on-the-ground in the watershed. This effort will be completed in two phases: (1) evaluate existing tracking systems to provide recommendations for the LIS tracking system, and (2) develop and implement the tracking system. The first phase of this effort is currently underway. Specific data gaps for this approach are listed below, and options for addressing these data gaps are provided in the "Suggested Data and Tool Improvements" section of this report.

- **An increase in scope of nitrogen control efforts is reported by each state, but different measures are used. Therefore, the efforts could not be summed on the watershed scale within this report.** For example, an increased scope of agricultural BMP implementation is reported by CTDEEP, MassDEP, and NHDES by BMP type and acreage covered. VTDEC also indicates an increase in the scope of programs, but uses different measures (the inception of NRCS and state program offerings relative to 1990 as well as the amount of funding provided for BMP implementation).

- **The extent to which activities are underreported is unknown. Reporting of an activity is typically required only when it is mandated by regulation (i.e., by MS4 permits) or when a voluntary activity is funded by a state or federal grant assistance program (i.e., Section 319 Grant Program).** For example, CTDEEP explains that under Connecticut's Clean Vessel Act, the discharge of treated or untreated boat sewage is prohibited in LIS, but only boat pump-out facilities receiving CTDEEP grant assistance are required to report the volume of boat sewage collected to CTDEEP. It is likely the results of this program are underreported, but the extent is unknown.

- **Nitrogen control activities in non-regulated areas are largely underreported.** For example, MassDEP found as a result of its community survey that non-MS4 communities typically do not keep records of BMPs. Similarly, Vermont and New Hampshire contain no MS4-regulated communities within the LIS watershed, and therefore VTDEC and NHDES are limited in capturing nitrogen removal resulting from public works activities in evaluating the TMDL. It is possible that some municipal activities in non-regulated areas were likely occurring pre-1990 (TMDL baseline) and have continued with the same level of effort; therefore, they may not be contributing to the additional nitrogen load reductions required in the TMDL.

- **Limited state access to reported results of local and federal programs.** For example, Nassau, Suffolk, and Westchester Counties in New York implemented fertilizer laws, but there are no reporting or evaluation requirements to support an assessment by NYSDEC of the results. Furthermore, data regarding the federal NRCS agricultural assistance programs are limited at the state level due to privacy concerns.

- **Programs for which reporting is required to the state may not account for all nitrogen load-related activities implemented as a result of a program.** For example, CTDEEP reports that towns conducting illicit discharge detection and elimination activities are not required to report their findings and subsequent solutions.

- **Programs for which reporting is required to the state may not account for all information necessary for determining nitrogen load reductions**. For example, New Hampshire's Shoreland Water Quality Protection Act Program tracks location, water body name, area of lot, impervious surface pre- and post-construction, post-construction area of alternative technologies used, buffer restored, and area of disturbed area. However, the database excludes tracking drainage area, attenuation, land use type, BMP type, and BMP condition—all of which are valuable characteristics for calculating nitrogen reductions. Similarly, MassDEP found that of the 373 individual BMPs reported in its community survey, 160 lacked data necessary to estimate total nitrogen reductions (i.e., weight of organic mass collected or area covered by BMP).

- **The timing of when reporting requirements were implemented limits retrospective TMDL evaluations.** For example, 319 Grant Program funded projects are required to be reported in the Grants Reporting and Tracking System, but reporting on nitrogen reduction statistics was not required until 2003.

- **Limited ability to differentiate between ongoing BMPs and BMPs implemented following TMDL implementation to avoid potential overestimates of nitrogen reductions**. For example, MassDEP accounted for ongoing housekeeping BMPs, such as street sweeping, toward total nitrogen load reductions. There is potential that some of the activities began prior to TMDL implementation, but it is difficult to determine when ongoing activities were first implemented or their scope due to limited recordkeeping at the municipal level and limited access to these records at the state level.

- **Lack of effectiveness in monitoring individual implementation activities**. For example, NRCS actively conducts follow-ups on NRCS-funded projects and associated BMPs for at least the first three years following BMP implementation. After three years, however, farmers are generally left on their own to continue BMP implementation/maintenance. NRCS does not conduct follow-up surveys on the rate of BMP implementation/maintenance beyond the three-year timeframe.

Suggested Data and Tool Improvements

The following data and tool improvements are suggested to address the limitations in achieving quantitative TMDL evaluations based on nitrogen load delivered to the Sound (Approach 1):

- Collect ambient water quality and flow data in areas of the upper basin states north of the Massachusetts-Connecticut state border and the Massachusetts-New Hampshire/Vermont state borders. Consider use of these data to recalibrate existing watershed models and/or conduct nitrogen trend analysis and to confirm if TMDL allocations for the upper basin states have been achieved.

- Conduct nitrogen trend analysis and subsequent modeling (as needed) using in-basin and upper basin ambient water quality monitoring data on watershed contributions of nitrogen delivered to the Sound by source, tributary, and state.

- Enhance the most recent in-stream nitrogen trend study with additional analyses to examine the influences of precipitation and in-stream flow on nitrogen loading and the implications for nitrogen source load (nonpoint versus point source).

- Conduct analysis of localized atmospheric nitrogen deposition in the watershed based on localized trends in vehicle emissions and monitoring data within or near the watershed.

Determine if the overall reductions in atmospheric nitrogen deposition anticipated in the TMDL based on CAAA implementation have been achieved. If needed, investigate the extent to which changes in precipitation influence wet atmospheric deposition rates and examine whether the ability of forested land to store nitrogen from atmospheric sources has changed. These topics are beyond the scope of LISS, but are important topics to investigate nationally.

The following data and tool improvements are suggested to achieve quantitative TMDL evaluations of the effectiveness of nonpoint source and stormwater nitrogen control efforts (Approach 2):

- Develop a flexible framework (tracking system) to track and account for the variety of nitrogen control efforts in place and generate quantitative estimates of nitrogen removal expected from on-the-ground practices (with attenuation considerations).
- To prepare for implementing a tracking and accounting system, identify the minimum set of parameters for each type of BMP necessary to generate a nitrogen removal estimate; cross-check those parameters with the data available as discussed in this report; and use the identified gaps in data to inform improvements in reporting requirements and voluntary/self-reporting.
- Develop a common methodology to estimate load reductions from various on-the-ground practices agreed upon by watershed management. Scientifically defensible nitrogen removal values must be applied. Management may consider existing values used in other watersheds and seek technical guidance for adapting these values to the LIS watershed.
- Attempt to measure the extent to which on-the-ground practices are underreported and, depending on the results, consider options to capture nitrogen removal from practices that are not reported. Also, to close gaps in reporting, consider options to encourage voluntary/self-reporting where reporting is not required; options include public recognition, grant funding requirements, or other incentives.
- Track drivers of nitrogen loading (land use/cover changes, conversions, and redevelopment) throughout the watershed to more effectively target future TMDL implementation efforts.
- Based on the minimum set of parameters necessary to generate nitrogen removal estimates for each type of BMP, identify options for improving communication/information-sharing among local, state, federal, watershed, and private agencies/organizations involved with nitrogen load-impacting activities.
- Consider integrating efforts of all agencies, organizations, and other entities involved with nitrogen-load impacting activities to better share data and information on these activities and enhance tracking and accounting system capabilities.
- Consider the timeframe and baseline for tracking and accounting for implementation efforts (ongoing, retrospective, and newly implemented).

- Consider sustainability, feasibility, and cost-effectiveness of tracking and accounting system needs, including population of database, frequency of output updates, quality assurance and quality control considerations, and public access and involvement in the user-interface and output.

Implementing these data and tool improvements would enable progress in (1) identifying watershed nitrogen trends and contributions relative to TMDL implementation efforts and (2) quantitatively estimating nitrogen load reductions expected from on-the-ground implementation efforts. However, the above suggestions are not recommended action steps, but rather suggested possibilities to reach outcomes that may be achieved through various approaches at the state and/or watershed level as deemed appropriate and most effective by management. The findings of this report and the suggestions to address data limitations that inhibit comprehensive quantitative analyses will also be considered in the ongoing TMDL reassessment process.

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Appendix

The table provides regulatory programs and permitted activities for stormwater runoff and nitrogen influencing activities in the Long Island Sound Watershed by state (see individual state sections of this report for more detail). These program descriptions were current as of September 2013 and are expected to change overtime.

Municipal Separate Storm Sewer Systems

Connecticut	Massachusetts	New Hampshire	New York	Vermont
Phase I General Description: Requires municipalities serving a population =/> 100,000 to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies. **Phase II General Description:** Requires municipalities serving a population < 100,000 to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies. **Requirements:** Registration, stormwater management plan, monitoring, and reporting. Nitrogen species include TKN, NO3 + NO2, NH3. Six minimum measures. Follow the Soil and Erosion Control Guidelines, Stormwater Quality Manual, as well as the LID guidance incorporated as appendices into these manuals.	**General Description:** Requires certain municipalities to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies. Phase I was issued in 1990; Phase II was issued in 1999, and updated in 2003, with another renewal currently being considered. Specifics: Phase I includes Boston and Worcester, which are populations =/> 100,000 Phase II includes 247 Towns and other public entities such as DCR, MWRA, and Mass DOT **Requirements:** Registration; develop stormwater management plans; prepare annual progress report to EPA on 6 Minimum Control Measures.	**General Description:** Since New Hampshire is a non-delegated state, the MS4 general stormwater permit is administered by EPA. There are currently no designated MS4 communities in New Hampshire within the Long Island Sound watershed. Depending on the extent of disturbance and if wetlands are impacted, construction and operation of many development activities are regulated under the State Water Quality Certification, Alteration of Terrain Permit, Shoreland Water Quality Protection Act Permit and/or Wetlands Permit programs as well as the EPA Construction General Permit program which are discussed below.	**General Description:** Municipal Storm Sewer Systems areas included evaluation of the need to make necessary amendments to the sewer use regulations based on the stormwater discharge characterization report (prepared as a result of the 1998 MS4 requirements), develop a stormwater monitoring program, estimation of seasonal stormwater pollutant loads, develop a track down and remediation program, inventory of industrial and waste handling facilities discharging to the MS4, assessment of controls, and submission of report/progress report on the implementation of MS4 requirements. **Requirements:** The SPDES Individual Permits have ongoing requirements for shoreline survey and outfall identification that surveys the shoreline of New York City including the MS4 areas. The SPDES Individual Permits also have some ongoing requirements in the best management practices (BMPs) for combined sewer overflows (CSO), which the City is also implementing in the MS4 areas. **Nontraditional MS4s** State or Federal government facilities, Metropolitan Transportation Authority (MTA) facilities	Vermont currently has no designated MS4 communities in the Long Island Sound watershed. However, Vermont does issue state permits for runoff from developed lands, outside the scope of the MS4 permit, and are addressed in the “Operational” State Stormwater Permit Program description below.

Industrial Stormwater

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Regulates industrial facilities with stormwater discharges that are engaged in specific activities listed in the permit. **Requirements:** Registration, stormwater management plan, monitoring, and reporting. Nitrogen species include TKN, NO3. Follow the Soil and Erosion Control Guidelines, Stormwater Quality Manual, as well as the LID guidance incorporated as appendices into these manuals.	**General Description:** EPA General Permit that regulates facilities with stormwater discharges from exposure of materials outside to precipitation. The original year of issuance was 1992, and the revised issuance date was 2008. There are currently approximately 1,100 registrants. **Requirements:** Registration; depends on Sector (approx. 30 of them), & type of raw material stored outside; Some monitoring. requirements particularly for metals	**General Description:** The NPDES Multi-sector General Permit (MSGP) regulates 11 categories of stormwater discharges associated with industrial activities. Since New Hampshire is a non-delegated state, the MSGP is administered by EPA. Depending on the extent of disturbance and if wetlands are impacted, construction and operation of many industrial activities are also regulated under the State Water Quality Certification, Alteration of Terrain Permit and/or Wetlands Permit programs which are discussed below. **Requirements:** For the MSGP, applicants must file a Notice of Intent or submit a No Exposure certification form showing that an MSGP is not required. MSGPs requirements include, but are not limited to, non-numeric technology-based effluent limits such as minimizing exposure, good housekeeping, maintenance and spill prevention, water quality based effluent limitations for discharges to impaired waters, antidegradation requirements, inspection requirements, preparation and implementation of Stormwater Pollution Prevention Plans (SWPPPs), monitoring and reporting requirements. Prior to issuance of NPDES permits, the State must certify that the permit will comply with state surface water quality standards.	**General Description:** Facilities are required to obtain permit coverage for stormwater discharges to surface waters of New York State through either an individual industrial SPDES permit, the SPDES Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity, or provide certification using the No Exposure Exclusion that industrial activities are not exposed to stormwater. **Requirements:** Facilities covered under the Industrial Stormwater SPDES General Permit are required to prepare a site-specific stormwater pollution prevention plan (SWPPP). SWPPPs are required to include structural and non-structural best management practices (BMPs) for each of the areas where industrial materials or activities are exposed to stormwater. Permitted facilities are required to perform periodic and annual compliance inspections and maintenance of the BMPs. Monitoring requirements for permitted facilities include quarterly visual monitoring and annual dry weather monitoring for all facilities and benchmark monitoring for many sectors of industrial activities and numeric effluent guidelines for some sectors. The individual SPDES Permits for large industrial facilities with industrial stormwater component are required to implement BMPs to runoff control BMP requirement in the Permit.	**General Description:** **"Multi-Sector General Permit"** Facilities are required to obtain coverage based on Standard Industrial Classification code. **Requirements:** BMP implementation i.e., Good Housekeeping, Erosion Prevention and minimizing Exposure to reduce potential pollutant discharges. Sectors required to monitor specifically for nitrogen: Agricultural Chemical and Industrial Inorganic Chemical manufactures, Soap and Detergent Manufacturers, sand and Gravel Mines, and Fabricated Metal facilities

Commercial Stormwater

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Regulates commercial sites with 5 or more acres of impervious surfaces. **Requirements:** Registration, stormwater management plan, visual inspection, and reporting. Follow the Soil and Erosion Control Guidelines, Stormwater Quality Manual, as well as the LID guidance incorporated as appendices into these manuals.	**No permit for stormwater associated with commercial activities in Massachusetts.**	**General Description:** Depending on the extent of disturbance and if wetlands are impacted, construction and operation of many commercial activities are regulated under the State Water Quality Certification, Alteration of Terrain Permit and/or Wetlands Permit programs as well as the EPA Construction General Permit program which are discussed below.	**General Description:** Sanitary wastewater discharges to groundwater are regulated by either the New York State Department of Health (NYSDOH), the NYSDEC, local Departments of Health and/or local building departments. Many counties Department of Health's have been delegated authority to issue permits for larger residential and commercial sanitary discharges to groundwater by both the NYSDOH and the NYSDEC. For individual household systems and smaller developments (typically less than 5 housing units) local building departments oversee these systems. SPDES General Permit for Private, Commercial or Institutional (PCI) Facilities discharging 1,000 to 10,000 gallons per day of sanitary wastewater to groundwater (GP-0-05-001). **Requirements:** This general permit authorizes the discharge to groundwater of 1,000 – 10,000 gallons per day of treated sanitary waste, without the admixture of industrial wastes, from on-site treatment works serving private, commercial, and institutional facilities using treatment units or processes referenced in *Design Standards for Wastewater Treatment Works – Intermediate Size Sewerage Facilities* (NYSDEC 1988, draft revised design standards in 2013). This general permit is applicable in the DEC regions 2, 3, 4, 5, 6, 7, 8 and 9.	**Contained as part of the "Operational" State Stormwater Permit.**

Construction Stormwater

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Requires developers and builders to implement stormwater management plans that will prevent the movement of soil and sediments off site and into nearby streams and water bodies. Applicable to disturbed areas > 5 acres. **Requirements:** Registration, stormwater management plan (during & post construction sediment controls). Follow the Soil and Erosion Control Guidelines, Stormwater Quality Manual, as well as the LID guidance incorporated as appendices into these manuals.	**General Description:** EPA Permit, certified by MA; Req. MA Stormwater Standards on any Construction Site > 1 Acre. The original year of issuance was 1995, and the revised issuance date was 2012. There are at least hundreds of registrants at any point in time, and this will vary according to the project duration, etc., of each project. **Requirements:** Registration; Stormwater management plan (during & post construction) that controls soils/sediment going of-site	**General Description:** The NPDES Construction General Permit (CGP) regulates stormwater discharges from construction activities that disturb one or more acres. Since New Hampshire is a non-delegated state, the CGP is administered by EPA. Depending on the extent of disturbance and if wetlands are impacted, construction and operation of many development activities are also regulated under the State Water Quality Certification, Alteration of Terrain Permit, and/or Wetlands Permit programs which are discussed below. **Requirements:** For the CGP, applicants must file a Notice of Intent. CGP requirements include, requirements for erosion and sediment control, stabilization and pollution prevention, water quality based effluent limitations for discharges to impaired waters, antidegradation requirements, inspection requirements, corrective actions, and preparation and implementation of Stormwater Pollution Prevention Plans (SWPPPs). Prior to issuance of NPDES permits, the State must certify that the permit will comply with state surface water quality standards.	**General Description:** Construction activities involving soil disturbances greater than 1 acre in New York City MS4 and surface water direct discharge drainage areas are required to obtain coverage under the SPDES General Permit for stormwater discharges from construction activity (currently GP-0-10-001). The construction stormwater SPDES General Permit coverage in New York City MS4 and direct discharge drainage areas is also required for construction activities involving soil disturbances of less than 1 acre, where the NYSDEC has determined that a SPDES permit is required for stormwater discharges based on the potential for contribution to a violation of a water quality standard or for significant contribution of pollutants to surface waters of New York State. **Requirements:** All construction activities covered under the Construction Stormwater SPDES General Permit are required to prepare a site-specific stormwater pollution prevention plan (SWPPP). All SWPPPs are required to include erosion and sediment control (E&SC) measures and pollution prevention/good housekeeping practices during construction. All construction projects are also required to prepare and implement a SWPPP with post-construction stormwater management practices. Post-construction stormwater management practices, required as part of the construction stormwater General Permit, are mostly stormwater quality controls.	**General Description:** Stormwater runoff from earth disturbance activity of one or more acres. **Requirements:** Development of an erosion prevention and sediment control plan.

Combined Sewers

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Existing CSO's are regulated following the 1994 EPA policy on combined sewer overflows. CSO communities are required to implement nine minimum controls and to develop and implement Long Term Control Plans. Grants are available for up to 50% of eligible costs and the remainder can be funded through low interest loans repaid over twenty years.	CSOs are regulated by both the Commonwealth of MA and the Federal EPA. MA adopted a Long-Term CSO policy in 1997, which requires approval and implementation of a Long- Term Control Plan for each of the 24 CSO communities. Actual implementation is funded through the communities themselves, with possible assistance from State Revolving Fund (SRF) money sources	**General Description:** CSOs are regulated under individual NPDES wastewater discharge permits issued for municipalities. Since New Hampshire is a non-delegated state, the NPDES program is administered by EPA. Prior to issuance of NPDES permits, the State must certify that the permit will comply with state surface water quality standards. Lebanon is the only community in the State with CSOs in the Long Island Sound watershed. **Requirements:** Lebanon is under a Consent Decree to eliminate all CSOs by separation by the end of 2020.	**General Description:** Most of NYC is serviced by combined sewers, and greater than 90% of the area of NYC within the LIS watershed is serviced by combined sewers. In 2012 the NYSDEC and NYCDEP signed an agreement to reduce combined sewer overflows (CSOs) using a hybrid green and grey infrastructure approach. **Requirements:** As part of the agreement, the NYCDEP will develop 10 waterbody specific long term control plans (LTCPs) plus one city wide LTCP to reduce CSOs and improve water quality in the water bodies around NYC. To date, the NYCDEP has spent over $1.8 billion to control CSO discharges which has resulted in a CSO capture rate of approximately 72%. Additionally, the NYCDEP has committed to spend an additional $1.6 billion on grey infrastructure that is projected to reduce current CSO discharges by 28%.	**Existing CSOs are regulated to develop and comply with Long Term Control Plans.**

Septic System Discharge

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: **Septic system discharges** > 5,000 gpd, those equipped with alternative treatment, and community systems fall under CTDEEP purview. Residential systems that are <2,000 gpd are managed by local municipalities and systems that discharge between 2,000 and 5,000 gpd are regulated by the Connecticut Department of Public Health. In addition, Section 7-247 of the Connecticut General Statues allows municipalities to create decentralized wastewater management districts to upgrade local septic systems to standards beyond the public health code. **Requirements:** Registration and wastewater management plan (for the general permit). Requirements of the individual permit are site specific and may include groundwater sampling, process monitoring, pump-out and inspection. Analysis of groundwater typically requires bacteria, pH, TDP, nitrogen (ammonia, nitrate, nitrite, TKN, total).	The Commonwealth is responsible for minimum codes (under Title V) for septic systems. Communities can choose to be more stringent. MA also requires, under Title V, inspections of septic systems on every home before its sale, and if not in compliance, requires the homeowner to remedy the problems in order to come into compliance before the home is actually sold. The Commonwealth has a grant program to assist homeowners to repair/replace the failing septic system in order to bring it into compliance. MA does not have a specific requirement for removal of Nitrogen (N) from Title V septic systems. MA does have an Innovative/Alternative Technology Development Program for Title V septic systems, which is located on Cape Cod**.**	**General Description:** The New Hampshire Department of Environmental Services (NHDES) Subsurface Systems Bureau is responsible for issuing permits for individual sewage disposal systems (ISDS). **Requirements:** ISDS designers and installers must be licensed by the NHDES Subsurface Systems Bureau. No ISDS can be installed and operated without a permit and on-site inspection by the NHDES Subsurface Systems Bureau.	**General Description:** For individual household systems and smaller developments (typically less than 5 housing units) local building departments oversee these systems. SPDES General Permit for Private, Commercial or Institutional (PCI) Facilities discharging 1,000 to 10,000 gallons per day of sanitary wastewater to groundwater (GP-0-05-001). **Requirements:** New York State Department of Health (NYSDOH) established regulations for residential wastewater treatment systems discharging < 1,000 gallons per day delegated to local health departments. Sanitary wastewater treatment plants <30,000 gpd to groundwater design standards set by NYSDEC (currently being revised).	**General Description:** **VTDEC Drinking Water and Groundwater Protection Division regulates underground wastewater discharges.** **Requirements:** **Discharges > 6,499 gpd are regulated under the Indirect Discharge Program rules.** **Discharges < 6,500 gpd are regulated under the Wastewater System Rules and permitted by the VTDEC Regional Offices.**

Water Quality Certification

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Regulates any applicant for a federal license or permit who seeks to conduct an activity that may result in a discharge into the navigable waters of the state, including all wetlands, watercourses, and natural and man-made ponds. Such persons must obtain certification from CTDEEP that the discharge is consistent with the federal Clean Water Act and the Connecticut Water Quality Standards. In making a decision on a request for 401 Water Quality Certification, CTDEEP must consider the effects of proposed discharges on ground and surface water quality and existing and designated uses of waters of the state. **Requirements:** Any conditions specified by CTDEEP and contained within a water quality certification become conditions of the federal permit or license.	MA 401 Water Quality Certification Regulation (314 CMR 9.00). Regulates new development and redevelopment activities in federal waters/wetlands. The original year of issuance was 1983, and the revised issuance date was 2009. There are about 50 applications per year. **Requirements:** For work in federal waters/wetlands: peak rate control, recharge, and water quality treatment.	**General Description:** Regulates any activity that requires a federal license or permit including, but not limited to, the construction and operation of facilities, that may result in a discharge to navigable waters. The purpose is to ensure the activity complies with state surface water quality standards. **Requirements:** Certifications include conditions necessary to ensure compliance with applicable surface water quality standards. For development projects conditions typically include monitoring, erosion protection during construction, pollutant loading analyses , implementation and maintenance of permanent stormwater BMPs designed per the Alteration of Terrain regulations and reporting requirements	**General Description:** The document "A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound", December 2000 established a total maximum daily load (TMDL) for nitrogen inputs into LIS to meet the dissolved oxygen (DO) water quality standards in existence at that time. **Requirements:** This TMDL was determined using a complex water quality model called LIS 3.0 which was used to identify DO improvements in LIS resulting from reductions from nitrogen and carbon loads to LIS through various management scenarios. Ultimately, it was determined that controlling nitrogen as the primary pollutant of concern, especially from WWTPs would also have a corresponding control or reduction in carbon loading to LIS, therefore, this TMDL was established to control nitrogen load to LIS to reduce the duration and extent of hypoxia in western LIS. The TMDL was anticipated to be implemented in phases, with the 2000 TMDL effectively focusing on "Phase III". The Phase III action for hypoxia management concluded that the TMDL should include a 58.5% reduction from the baseline nitrogen load to LIS from in-basin sources (New York and Connecticut).	**Not specifically reported in VT DEC section, but Water Quality Certification does occur.**

Wetlands Protection

Connecticut	Massachusetts	New Hampshire	New York	Vermont
Inland Wetlands and Watercourses Act: CTDEEP provides oversight, training, regulatory, and technical assistance to CT's municipal inland wetland agencies. Delegated municipalities regulate activities that affect wetlands and watercourses within boundaries with over 4,000 actions taken annually and reported to CTDEEP annually.	**General Description:** MA Wetland Act and Regulation (310 CMR 10.00) regulates new development and redevelopment activities in wetland resources and buffer zone. . The original year of issuance was 1996, and the revised issuance date was 2008. There are about 5,000 Notices of Intent (NOIs) filed each year. **Requirements:** For work in resource areas and buffer zone: peak rate control, recharge, and water quality treatment.	**General Description**: The NHDES Wetlands Bureau administers the Wetlands Permit program to preserve and protect jurisdictional wetlands from unregulated alteration. Jurisdictional wetlands include, but are not limited to, swamps, bogs, marshes, forested wetlands, wet meadows, vernal pools, prime wetlands, lakes, ponds, tidal waters, rivers and streams, and all land within 100 feet of the highest observable tide line. The goal of the program is no net loss of wetland function or value which is typically achieved through mitigation. **Requirements:** In most cases applicants proposing to impact wetlands must apply for and receive a wetlands permit. Requirements typically include, but are not limited to, implementation of erosion and sedimentation control measures during construction, requirements to minimize wetland impacts and to provide mitigation where there is a loss of wetland function or value.	**General Description:** State laws regarding Tidal Wetland Land Use Regulations (6 NYCRR Part 661) contain limitations for development in applicable areas. **Requirements:** Erosion and sediment controls are also included in the Permits issued by NYSDEC for construction activities in the tidal and freshwater wetland areas.	**General Description:** **VTDEC Watershed Management Division regulates activities in wetlands according to the Vermont Wetland Rules.**

Fertilizer Legislation

Connecticut	Massachusetts	New Hampshire	New York	Vermont
Connecticut Fertilizer Law of 2008, Connecticut General Statutes 427a § 22-111a-111x (as amended by Public Act 09-229). This law essentially houses all responsibility for registering, labeling, inspecting and generally regulating all fertilizers, intended for farm and nonfarm use, with the CT Dept. of Agriculture and its Commissioner. CGS § 22-111w states that bulk fertilizers must be stored in a way that minimizes their exposure to the environment, and that fertilizers must be applied according to "best management practices" and regulations by the Commissioner. In 2012, Connecticut passed PA 12-155 "An Act Concerning Phosphorus Reduction in State Waters". The Act establishes certain restrictions on using fertilizer, soil amendments, or compost containing phosphate. Connecticut continues to participate in the Northeast Voluntary Turf Fertilizer Initiative.	Amending Legislation was passed last year in MA on phosphorus controls. The regulations governing this amending Legislation are to be promulgated by the MA Department of Agriculture, with the help of MassDEP. The proposed regulations will ban the use of phosphorus on residential lawns, unless they are new lawns or where through a soil test it shows that TP is needed. It will also be proposed that cities/towns will get some sort of credit through their MS 4 permit on this.	Efforts to reduce nutrient loadings from fertilizer applied in New Hampshire are gaining momentum with the 2012 agreement by the New England Governor's Committee on the Environment along with the environmental commissioners from the New England states to initiate a voluntary regional approach to better control nutrient pollution from fertilizer. In addition, the New Hampshire legislature passed a bill in 2013 that places limitations on nutrients (nitrogen and phosphorus) in residential turf fertilizer similar to those recently enacted in Maryland and New Jersey.	NYS and Nassau, Suffolk and Westchester Counties all have recently implemented fertilizer laws. The county laws all call for a reduction or discontinuation of the use of fertilizer on municipally owned land. Currently there are no reporting requirements to quantify the benefit of these laws.	A law enacted by the Vermont legislature relating to the application of fertilizer became effective on January 1, 2012. The primary focus of the law is to limit the use of nonagricultural turf fertilizers and to reduce the likelihood of nutrients from entering surface waters. Portions of this law limit the type of nitrogen fertilizer that can be applied to nonagricultural turf; specifically, no nitrogen fertilizer may be applied to turf if the nitrogen content consists of less that 15% slow-release nitrogen. Additionally, regarding turf fertilizer application in general, prohibitions include: 1) application to impervious surfaces, 2) applications to turf before April 1st or after October 15th or at any time the ground is frozen, and 3) applications to turf within 25 feet of waters of the state. Golf courses are also required to develop and submit to the State a nutrient management plan for the use and application of fertilizers. The goal is to ensure proper fertilizer applications consistent with agronomic rates for site specific conditions of the golf course.

Concentrated Animal Feeding Operation (CAFO)

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Connecticut has 10 Type 1 Concentrated Animal Feed Operations (CAFO) and 34 medium Animal Feed Operations (AFO). The AFOs may meet the conditions of the draft general CAFO permit (i.e. hold enough animals, discharge to a waterbody) to be classified as Type 2 (medium) CAFOs. If determined so by CTDEEP, they will be included in the permitting program. CTDEEP is currently working on the draft general permit and it is expected to be finalized mid-2013.		**General Description:** CAFOs are regulated under the NPDES permit program. Since New Hampshire is a non-delegated state, the NPDES program is administered by EPA. To date, no CAFOs have been issued in New Hampshire within the Long Island Sound watershed. **Requirements:** Prior to issuance the State must certify that the permit will comply with state surface water quality standards.	**General Description:** The SPDES General Permit for Concentrated Animal Feeding Operations (CAFOs) (GP-0-09-001) requires coverage for all Large and Medium CAFOs (existing and new) and small animal feeding operations that are designated by the New York State Department of Environmental Conservation as a CAFO or request coverage. The permit requires that a Comprehensive Nutrient Management Plan (CNMP) be developed and maintained for each facility covered by this permit. The CNMP must address all areas where manure, litter, process wastewater or fertilizers are produced, land applied or stored on or for use by the facility. For all CAFOs the CNMP must also consist of an implementation schedule that includes at a minimum the following: 1) Any required new and any necessary updates or replacement of existing Best Management Practices (BMPs). 2) An estimate of the installation of BMPs not yet needed for compliance with this general permit that will be needed to address future operational or management changes at the CAFO. 3) Any additional BMP enhancements being implemented by the facility beyond the requirements of this general permit. The permit requires an annual manure analysis that mandates all CAFOs must analyze each individual land-applied waste source at least once annually for nitrogen and phosphorus in accordance with applicable NRCS standards.	**Concentrated Animal Feeding Operations (CAFOs) General Permit:** The Vermont statewide CAFO general permit is currently on notice for public comment. The comment period closes April 29, 2013. While the permit is not pollutant (nitrogen) specific, any farm that discharges to a surface waterbody can be required to obtain a permit. **Medium Farm Operations (MFOs) General Permit:** Prohibits discharges of wastes from a farm's production area to waters of the state and requires manure, compost, and other wastes to be land applied according to a nutrient management plan. **Large Farm Operations (LFOs) Individual Permit:** Individual permitting process only for farms of a certain size; prohibits the discharge of wastes from a farm's production area to waters of the state and requires the farm to land apply manure, compost, and other wastes according to a nutrient management plan. LFO permits are individual to each farm and also regulate odor, noise, traffic, insects, flies, and other pests. If a LFO falls within the CAFO permit coverage, a CAFO permit will still be required

Other State Stormwater Regulatory Programs

Connecticut	Massachusetts	New Hampshire	New York	Vermont
General Description: Underground Injection Control limited to domestic waste and stormwater.	**General Description:** **"Underground Injection Control (310 CMR 27.00)".** Requires stormwater well registration **Requirements:** Stormwater wells must comply with MassDEP Stormwater Standards	**Alteration of Terrain (AoT) Permits** **General Description:** Applies to the construction and operation of earth moving activities disturbing more than 100,000 square feet of contiguous terrain (50,000 square feet, if portion is within the protected shoreland) or greater than 2,500 square feet with a grade of 25 percent or greater within 50 feet of any surface water. Also applies to timber harvesting and trail construction. Normal agricultural operations are exempt. AoT permits are issued by the NH DES Alteration of Terrain Bureau. New Hampshire Department of Transportation (NHDOT) highway projects do not need an AoT permit but must incorporate practices that are substantially equivalent to those of the AoT program. **Requirements:** Must comply with AoT regulations (Env-Wq 1500) which includes erosion and sediment control during construction, and permanent BMPs to protect surface water quality including peak runoff, channel protection, groundwater recharge and stormwater treatment requirements. **Shoreland Water Quality Protection Act (SWQPA) Permit Program** **General Description:** The SWQPA permit program protects shoreland to maintain the integrity of surface waters. The protected shoreland extends 250 feet landward from the reference line of protected waterbodies which includes lakes, ponds, and impoundments greater than 10 acres, fourth order and greater streams and rivers and the highest observable tide line for coastal waters. **Requirements:** Impervious surface area limitations, setback requirements for septic systems, natural woodland buffer limitations, primary building setbacks, maintenance of natural ground cover, no fertilizer application within 25 feet of protected shoreland and only low phosphorus, slow release nitrogen fertilizer beyond 25 feet.	**General Description:** The United States Department of Agriculture Natural Resources Conservation Service (NRCS) manages the Environmental Quality Incentives Program (EQIP), a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. In addition, the New York State Agricultural Environmental Management (AEM) Program, under the direction of the New York State Soil and Water Conservation Committee (NYS SWCC) and the New York State Department of Agriculture and Markets (NYSDAM), coordinates state and local agencies and the private sector to provide technical and financial assistance to address environmental and nonpoint source issues on farms. **Requirement:** AEM planning projects typically address farm environmental assessments or individualized Comprehensive Nutrient Management Plans. Implementation projects cover a wide range of BMPs, including manure storage, barnyard runoff and pasture management, erosion control and waste management. Evaluation projects focus on achievements and stewardship at individual farms. The significant majority of funding for planning and implementation activities is from the NYS Environmental Protection Fund (EPF) through the Agricultural Nonpoint Source Abatement and Control Program, also referred to as Ag-NPS implementation projects.	**The State [Vermont] Stormwater Permit Program or "Operational or Post-Construction"** **General Description:** Projects creating more than one acre of new impervious surface, or projects that expand existing impervious surfaces where the total resulting impervious surface is greater than one acre require permit coverage. Projects located within an impaired watershed must apply for individual permit coverage. **Requirements:** Implementation of a stormwater management system designed in Compliance with the Vermont Stormwater Management Manual (VSMM).