Evaluation of Stormwater and Nonpoint Source Control Efforts in the Long Island Sound Watershed

Connecticut Department of Energy and Environmental Protection
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I Introduction

Nonpoint source (NPS) pollution in Connecticut is largely the result of land use patterns and local land use decision making. It comes from a variety of human activities including fertilizer applications, illicit discharges, animal waste and agriculture activities. Pollutants from such activities are washed off of impervious surfaces by rainfall and carried into nearby waterways. In some cases, NPS pollution impacts groundwater due to improperly functioning septic systems. In Connecticut, stormwater runoff from urban areas and construction activities are two of the most significant categories of nonpoint source pollution. The Connecticut Department of Energy and Environmental Protection (CTDEEP) has worked to develop programs, technologies, and legislation with both local and national significance that are protective of water resources. Some of these programs are regulatory and others provide technical support to regulatory programs, such as the Guidelines for Soil Erosion and Sediment Control (2002), as well as the Stormwater Quality Manual (2004). Educational and informative programs also serve to address pollution sources. Some programs are designed to achieve primary nitrogen reductions and others likely achieve reductions as a secondary outcome.

In 1996, CTDEEP took initial steps towards a comprehensive multi-media watershed management approach by establishing a Watershed Management and Coordination Section to oversee the department's watershed organization efforts. Staff in this section are assigned to two or three priority watersheds, and act as liaisons between the department's base program staff, other state and regional agencies, and local stakeholders. The Bureau of Water Management also developed a written watershed management strategy (Appendix A) to determine and assign roles and responsibilities among the numerous state, regional, and local entities that have a stake in a watershed approach to water resources management. Annually, the program prepares an evaluation report of its activities and accomplishments (Appendix B).

Nonpoint source management is also a task of CTDEEP's Office of Long Island Sound Programs (OLISP). OLISP oversees development within the coastal zone by providing assistance and training to coastal municipalities to identify various nonpoint source pollution methods to protect coastal water quality. OLISP has developed and disseminated a manual describing BMPs for urban runoff and marina operation and maintenance, as well as model stormwater, and erosion and sediment control ordinances.

The following pages outline Connecticut's NPS and stormwater control programs administered by CTDEEP, other state agencies, municipalities, and cooperative entities. This information is presented as required by the Enhanced Implementation Plan (EIP) agreement between the Long Island Sound watershed states and Federal Environmental Protection Agency (EPA). The EIP directs the watershed states to complete a preliminary evaluation of stormwater and nonpoint

source efforts to qualitatively assess whether efforts are adequate for meeting the 2000 total maximum daily load (TMDL) load allocations for nitrogen to Long Island Sound. As part of this process, CTDEEP prepared an inventory of Connecticut's NPS/stormwater control efforts which is included as Appendix C.

II Drivers of Change

Throughout this report "drivers of change" are discussed, although not specifically called out as such. Drivers of change refer to factors that are expected to impact the nitrogen load to LIS. Some examples include land cover change from forested to developed, fertilizer use, and the number of septic systems. They can be organized into two major nonpoint source groups: agriculture and urban. Drivers of change discussed in this report and their locations within this report are included below.

It is important to note that although these factors are referred to as drivers of change, the overall assessment of their impact on nitrogen loading may vary greatly. For instance, a mapped increase in the developed land cover category fails to reveal if Best Management Practices (BMPs) were implemented within the newly developed area. As such, the degree of nitrogen load increase will vary with BMPs.

III Regulated Stormwater and Other Permitting Programs

CTDEEP is responsible for administering the EPA's National Pollutant Discharge Elimination System or NPDES to protect water resources. The NPDES Storm Water Program, in place since 1990, regulates discharges from municipal separate storm sewer systems (MS4s), construction activities, industrial activities, and commercial activities. A summary of Connecticut's general stormwater permits is presented in Table 1.

Table 1 - Connecticut's Regulated Stormwater Permit Programs.

Permit	General Description	Number of Registrants	Original Issue Date/ Revised Date	Basic Requirements
General Permit for the Discharge of Stormwater Associated with **Industrial** Activity	Regulates industrial facilities with stormwater discharges that are engaged in specific activities listed in the permit.	1650	1992/2010	Registration, stormwater mgt plan, monitoring, and reporting. Nitrogen species include TKN, NO3.
Stormwater Associated with **Commercial** Activities General Permit	Regulates commercial sites with 5 or more acres of impervious surfaces.	240	1992/2009	Registration, stormwater mgt plan, visual inspection, and reporting.
Stormwater Associated with **Construction** Activities General Permit	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.	450	1995/2009	Registration, stormwater mgt plan (during & post construction sediment controls)
Stormwater from **Municipal** Separate Storm Sewer Systems General Permit				
Phase I	Requires municipalities serving a population =/> 100,000 to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies.	1	2005	
Phase II	Requires municipalities serving a population < 100,000 to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies.	113	2004/2011	Registration, stormwater mgt plan, monitoring, and reporting. Nitrogen species include TKN, NO3 + NO2, NH3. Six minimum measures.

To further the goals and objectives of the NPDES legislation, CTDEEP conducted an evaluation to incorporate low impact development (LID) best management practices (BMPs) in to its regulatory policy. The primary goals of this evaluation were to:

- Establish LID and pollution prevention, performance goals, and criteria for management practices common to Stormwater General Permit implementation.
- Identify how the performance goals and criteria can be most effectively incorporated into the Stormwater General Permit(s) to meet permit limits and conditions; and
- Identify mechanisms for incorporating LID BMPs and pollution prevention practices into the Stormwater General Permit(s) for priority attention.

Based on the recommendations of the LID/general permit evaluation (discussed above), CTDEEP incorporated Low Impact Development techniques into two support manuals: the Guidelines for Soil Erosion and Sediment Control (2002) and the Stormwater Quality Manual (2004) as appendices. More information on the LID evaluation can be found on CTDEEP's website at http://www.ct.gov/dep/cwp/view.asp?a=2719&q=459488.

a. Description of nitrogen control requirements

Industrial General Permit:
Section 9(c) of the general permit requires the permittee to develop and implement a stormwater pollution prevention plan following specific guidelines, such as to identify and summarize potential pollution sources. Section 5 (g) of the industrial general permit includes a stipulation to address TMDL waterbodies in the stormwater management plan when applicable. CTDEEP can inform a permittee that additional controls are necessary in order to meet the waste load allocation if the discharge is to impaired waters with a TMDL or that an individual permit must be obtained. The permit includes specific requirements (section 3(b)(9)) for new dischargers to comply with if they will be discharging to an impaired or TMDL waterbody. The industrial general permit requires monitoring (section 5(e)) for several parameters, including TKN and NO3, and benchmark values based on monitoring data collected by permitted industries between 2003 to 2007 are also included. Benchmark values for TKN and NO3 are 2.30 mg/L and 1.10 mg/L, respectively. If the average of four semiannual values for any parameter exceeds its benchmark, the permittee must take steps in accordance with section 5 (e.B.iv) of the general permit to reduce the exceeded parameter. These steps include review and modification to the SWMP to include additional efforts to address the exceedence and continued monitoring; or documentation for approval by the commissioner that no further reductions are achievable and continued monitoring.

MS4 General Permit:
Under section 5(b), the permittee must develop a stormwater management plan designed to reduce the discharge of pollutants to the maximum extent practicable, to protect water quality and to satisfy the Clean Water Act. The plan is required to address six minimum measures including public education and outreach, public involvement and participation, illicit discharge detection and elimination, outfall mapping, construction site stormwater controls, post-construction stormwater management, pollution prevention and good housekeeping. The permit also includes a stipulation to address TMDL waterbodies in the stormwater management plan when applicable (section 6(k)). The MS4 permit requires monitoring (section 6(h)) for several parameters, including NH3, TKN, and NO2+NO3.

Other:
General stormwater management activities will likely result in nitrogen reductions or prevention of nitrogen into nearby waterbodies. Activities include those specified in the Guidelines for Soil Erosion and Sediment Control (2002), as well as the Stormwater Quality Manual (2004). LID techniques have been incorporated into these two manuals based on the recommendations of the LID/general permit evaluation (discussed above). In addition, all stormwater permits require the permittee to follow the Soil and Erosion Control Guidelines, Stormwater Quality Manual, as well as the LID guidance incorporated as appendices into these manuals.

The Guidelines for Soil Erosion and Sediment Control were initially issued in 1985 and were republished in 1988 with some corrections. The 2002 edition contained major changes to the format, incorporation of technological advancements, and placed a greater emphasis on protecting LIS from sediment borne nutrient pollution. They are intended to provide information to state and local agencies and the general public on soil erosion and sediment control. The guidelines also fulfill the requirements of Connecticut's Soil Erosion and Sediment Control Act (see Section IV e) by providing guidance to municipal planning and zoning commissions.

The purpose of the Stormwater Quality Manual is to provide guidance on the measures necessary to protect the waters of the State of Connecticut from the adverse impacts of post construction stormwater runoff. The guidance provided in this manual is applicable to new development, redevelopment, and upgrades to existing development. The manual focuses on site planning, source control and pollution prevention, and stormwater treatment practices. Related topics, such as erosion and sediment control, stormwater drainage design and flood control, and watershed management are secondary considerations in this manual.

Permit Revisions:
The Phase I MS4 permit has been drafted with a focus on illicit discharge detection elimination (IDDE) requirements. The permit includes IDDE methodology and will result in the collection of relevant progress tracking information, such as the number of outfalls corrected. A hearing regarding this permit is expected by summer, 2013. It is anticipated that the construction and Phase II MS4 general permits will be revised with nitrogen limits, expanded sampling requirements, and language specific to TMDL and impaired water bodies. This language will be similar to the most recent version of the industrial general permit discussed above. In addition, CTDEEP has included specific performance standards (i.e. one inch runoff control) in the new construction permit(10/1/13). These performance standards will be applicable during construction, as well as after construction. The renewed MS4 general permit may include the half inch rule for ultra urban conditions with BMPs for specific pollutants, as well as a provision for municipalities to investigate the source of a pollutant known to be causing water quality impairments.

b. Estimated Effectiveness of Nitrogen Controls or Other Regulatory Programs

CTDEEP estimated the effectiveness of nitrogen controls using actual data submitted as permit compliance under the industrial stormwater general permit.

Since 1995, CTDEEP has maintained a database of the monitoring results for the industrial general permit which contains data from approximately 1400 to 1700 facilities. Annually, the data is analyzed for trends in indicator parameters, such as NO3 and TKN. Figures 1 and 2 represent the 50^{th} and 95^{th} percentiles, respectively, of the industrial stormwater data for both NO3 and TKN. The figures demonstrate a decreasing trend in both constituents. For the 50^{th} percentile data, a 39% reduction occurred for NO3, and TKN had a 9% reduction (Figure 1). In the 95^{th} percentile data, a 50% reduction occurred for NO3, and 29% for TKN (Figure 2). The greatest reduction can be found in the 95^{th} percentile which represents the highest NO3 and TKN concentrations. This is consistent with the general acceptance that the greatest reductions are achievable from the highest concentrations.

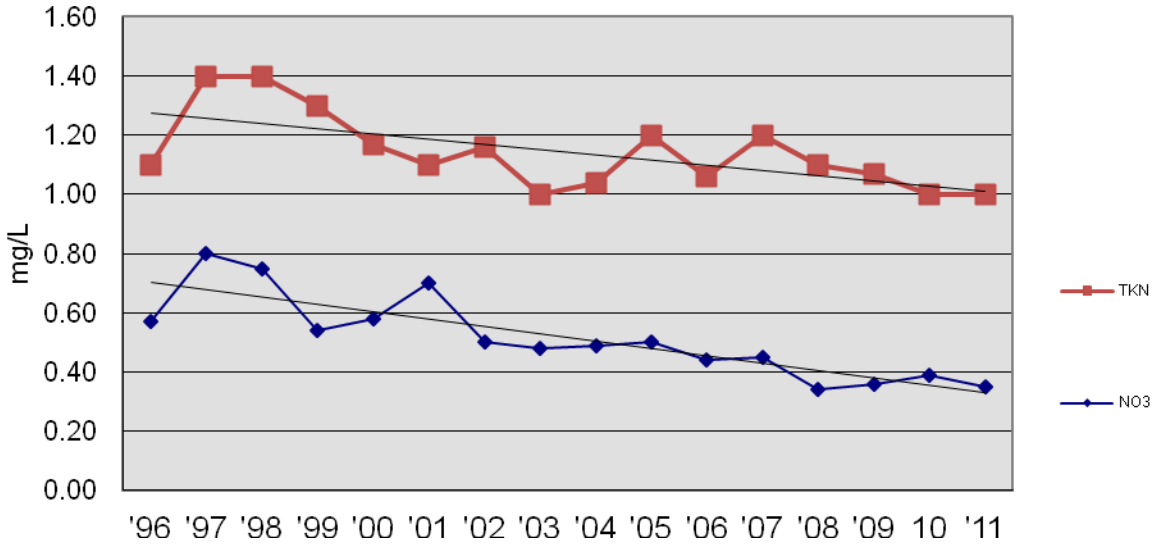


Figure 1 - Graph of Industrial Stormwater NO3 and TKN data, 50th percentile.

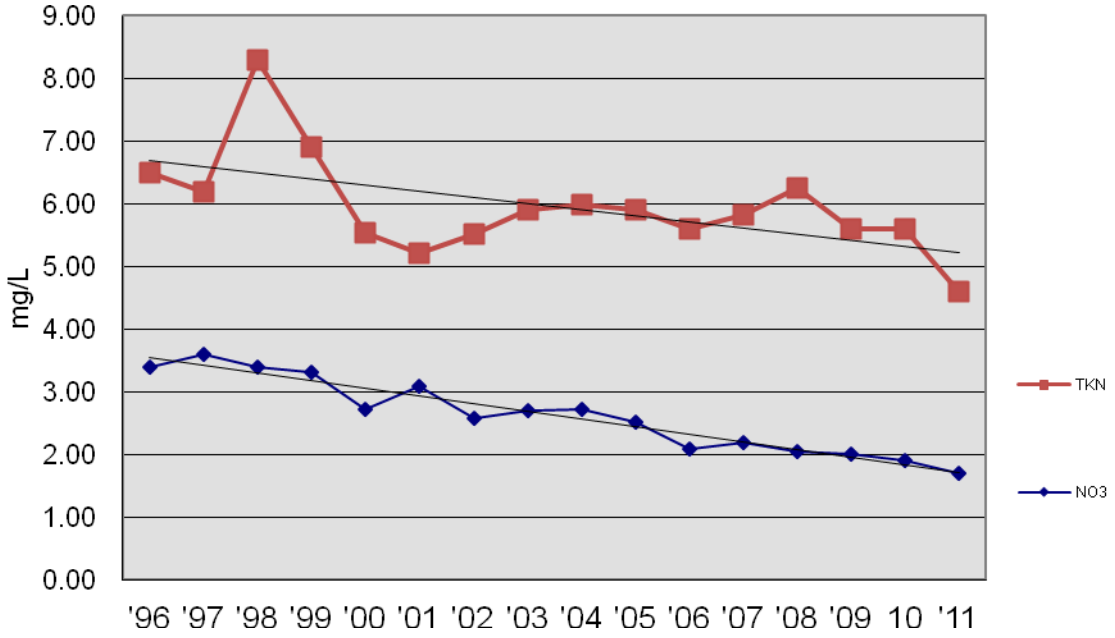


Figure 2 - Graph of Industrial Stormwater NO3 and TKN data, 95th percentile.

The MS4 permit requires monitoring and data has been collected since 2004. An analysis of this data proved it to be too variable to draw conclusions regarding trends in nitrogen since issuance of the permit. The dataset contains sampling results submitted by 114 municipalities at three land use types inclusive of their jurisdiction. Because the sampling locations vary from year to year, and identification of the land use types is questionable, as well as the shorter time frame of the dataset, it is considered to be unreliable at this time to demonstrate trends.

c. Relative change in scope and effectiveness of program from 1990 to present

In 1985, Connecticut prepared the Guidelines for Soil Erosion and Sediment Control in response to the Soil Erosion and Sediment Control Act passed by the Connecticut General Assembly in 1983. In 2002, the guidelines were further developed to incorporate advancements in controls and to place a greater emphasis on protecting LIS from sediment borne nutrient pollution. In 2004, Connecticut DEEP issued the Stormwater Quality Manual. Both of these manuals now include LID guidance and are required by all stormwater general permits.

The stormwater permitting program was administered after 1990. Between 1990 and 2012, over 2,000 commercial and industrial facilities, construction sites, and municipalities that contain designated urbanized areas have operated under stormwater general permits. Through this process, permittees have been made aware of their impact on the environment and have taken steps towards reducing stormwater pollution. Revisions continue as scheduled every five years and each revision includes increasing stormwater controls.

Figure 3 illustrates the coverage of stormwater permits in Connecticut as of 2012. Stormwater permittees tend to be located in areas of the state that exhibit denser development (i.e. more urbanized land cover). Figure 4 demonstrates the locations of “urbanized areas” as defined by the US Census Bureau. Of the 169 Connecticut municipalities, 130 of them include designated urbanized areas and 114 of these municipalities are subject to the requirements of the MS4 permit (Phase I and Phase II).

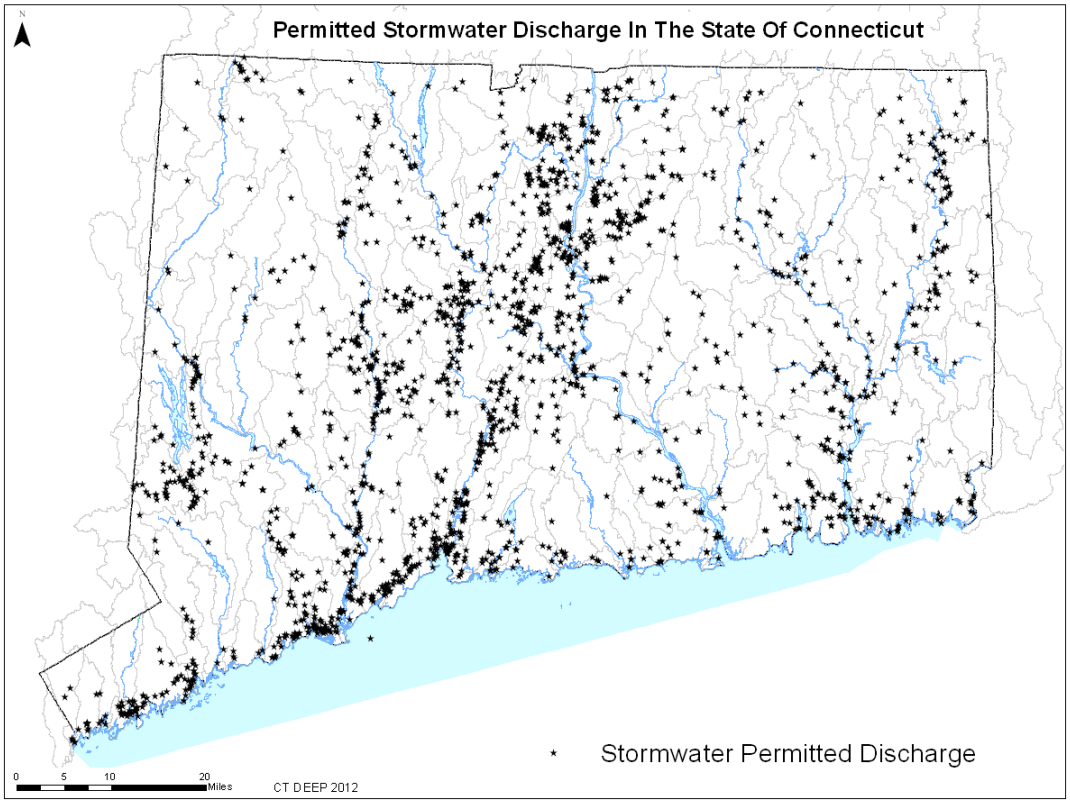


Figure 3 - Stormwater Permits in Connecticut.

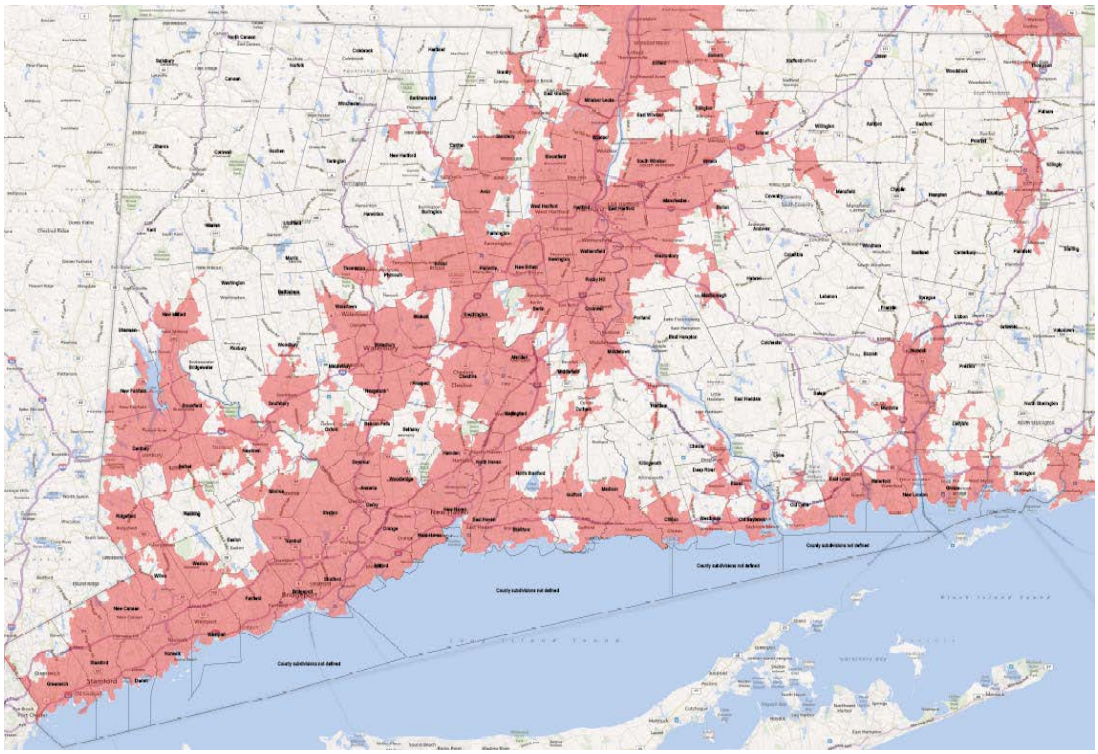


Figure 4 - Urbanized (MS4) areas in Connecticut.

IV Nonpoint Source

a. Agriculture

CTDEEP has formed partnerships with federal and state agencies with an emphasis on nutrient reductions from agricultural properties through the implementation of Best Management Practices. Examples of BMPs include:

- Livestock exclusion fencing
- Manure collection and storage
- Nutrient management (remove, reuse, land application guidelines)
- Fertilizer use
- Cover crops
- Vegetated buffers and filter strips
- Covered heavy use areas
- Diverting clean water

Recently, CTDEEP developed a location map of primary animal agricultural activities that include poultry and cow management for its statewide bacteria total maximum daily load. This map shows the concentration of animals throughout the state (Figure 5).

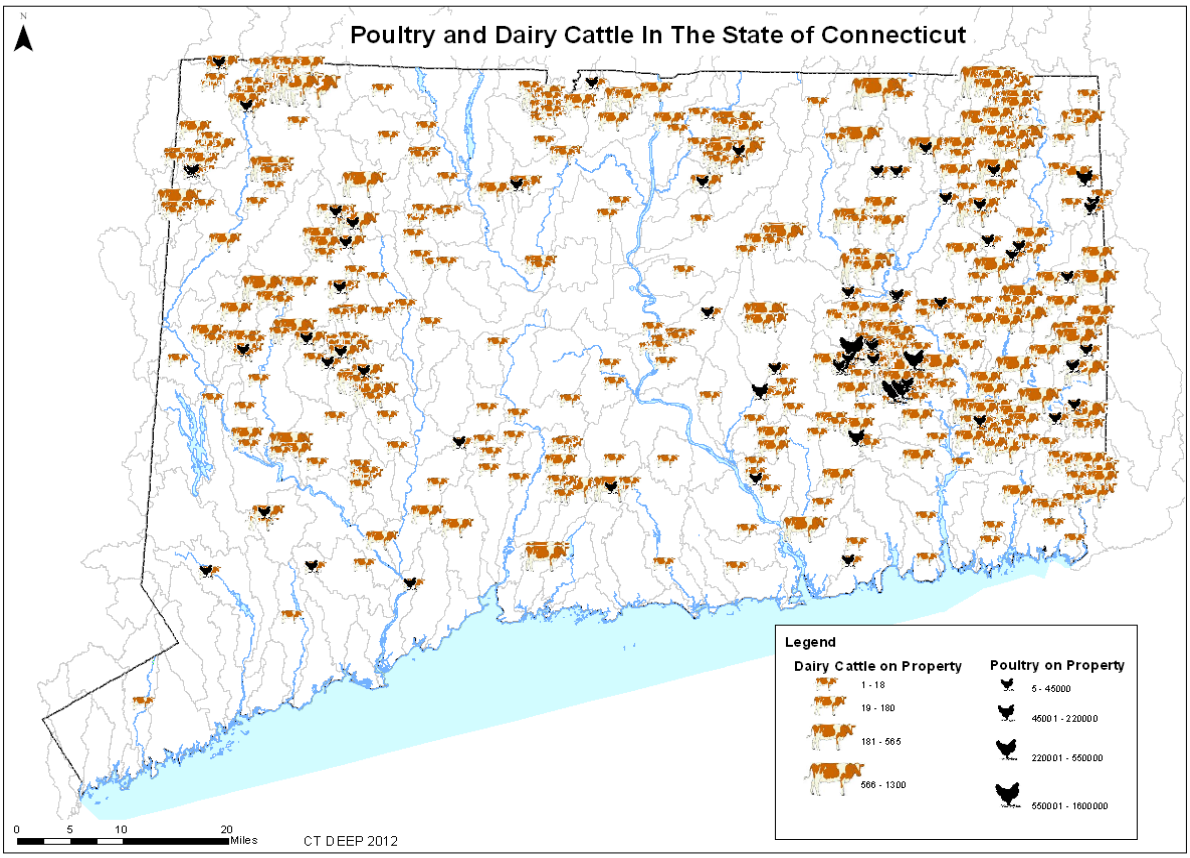


Figure 5 - Dairy and Poultry Agriculture throughout Connecticut.

i. State programs

During the 1990 to 2012 period, CTDEEP approved 269 Nutrient Management Plans (NMPs). The NMPs are effective for 3-5 years or as long as the farm is under contractual obligation with CTDEEP or NRCS. Structural installations, such as manure storage and silage leachate collection are designed to be longer term. The number of farms implementing NMPs varies yearly. Nutrient Management Plans include five specific elements:

- Adequate storage of manure and wastewater,
- Clean water diverted from production areas,
- Land application of manure and wastewater,
- Management of dead animals,
- Record keeping to document implementation.

Connecticut is able to offer technical and financial support to farm businesses in their farm waste efforts through the Partnership for Assistance on Agricultural Waste Management Systems (partnership). This cooperative effort includes: USDA Natural Resources Conservation Service (NRCS), USDA Farm Service Agency, University of Connecticut Cooperative Extension System, Connecticut Conservation Districts, the Connecticut Department of Agriculture, and CTDEEP. Through this partnership, a farm business may obtain waste management planning, structure design, and qualify for financial assistance as well as help in procuring required permits.

In cooperation with the partnership, the NRCS provides cost sharing for agricultural improvements that will help meet water quality and other environmental objectives through its Environmental Quality Incentive Program (EQIP). This program began in 1985 with the passing of the Farm Bill and been continued through subsequent renewals (1996, 2002, 2008). Based on state priorities, EQIP offers 5 to 10 year contracts that provide incentive payments and cost sharing for conservation practices. Cost sharing may pay up to 75% of the cost of structures and up to 100% of certain management practices. All EQIP funded projects must meet NRCS technical standards. Projects supported through the NRCS are provided below in section ii.

In the early 1990's, the Connecticut Department of Agriculture began offering funding through its Environmental Assistance Program (EAP) for Connecticut farmers. This program was designed to supplement the NRCS EQIP program. Any projects funded through this source would also be accounted for in the NRCS database discussed below in section ii.

ii. Natural Resources Conservation Service (NRCS) programs

NRCS administers a number of programs associated with agriculture activities that are designed to improve agriculture land use, production, and

conservation of land and water resources. One such program is the Conservation Reserve Program (CRP). This is a voluntary program available to agricultural producers to help them use environmentally sensitive land for conservation benefits. Producers enrolled in CRP plant long-term, resource-conserving covers to improve the quality of water, control soil erosion, and develop wildlife habitat. In return, participants receive rental payments and cost-share assistance. Contract duration is between 10 and 15 years. Other programs include financial support for conservation stewardship, wetland and grassland protection, and watershed protection. Details regarding these programs can be found on NRCS website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/.

Through the EQIP program, farms with approved NMPs work with NRCS to implement their NMPs. NRCS provided CTDEEP with a list of practices that were implemented within HUC12 basins. For legal reasons, NRCS is not permitted to share the exact locations of farms that they work with. CTDEEP coded and sorted 44,012 entries included in the NRCS database. These entries represent implementation activities that occurred between 2004 and 2011. They were sorted into three major categories: erosion control, nonpoint source control efforts, and nutrient management. The most utilized conservation practices that were determined most likely to reduce nitrogen export are presented in the following table.

Table 2 - NRCS most common practices that are likely to reduce N export.

	Applied Area	Units
Erosion Control		
All practices - acres	24,331.8	acres
All practices - feet	168,809.3	feet
All practices	116,052.0	square feet
Conservation Crop Rotation	4,377.9	acres
Contour Farming	1,754.6	acres
Cover Crop	2,585.2	acres
Diversion	7,015.2	feet
Forage & Biomass Planting	2,026.9	acres
Forage Harvest Mgt	7,801.1	acres
Nonpoint Source		
All practices - acres	25,623.0	acres
All practices - feet	675,609.0	feet
Fence	617,448.2	feet
Integrated Pest Mgt	3,572.5	acres
Nutrient Mgt	18,655.8	acres
Pipeline	58,160.8	feet
Prescribed Grazing	3,354.7	acres

Nutrient Management		
All practices - acres	9,727.6	acres
All practices – cubic feet	4,011.0	cubic feet
Silage Leachate Collection and Transfer	4,011.0	feet
Waste Recycling	8,959.1	acres

iii. Innovative Farm Related Projects

Through the partnership, CTDEEP has been involved in a number of innovative farm programs. One example includes the Blackberry River Watershed manure management project. This initiative consisted of seven livestock farmers in the towns of Canaan and North Canaan that have worked together to implement manure management practices. Such practices include composting manure in a controlled facility as well as manufacturing CowPots. In its first year, the project removed approximately 144,500 pounds of nitrogen from the waste stream. This project was funded through a combination of 319 grants and Supplemental Environment Project funds.

iv. CAFO permits

Connecticut has 10 Type 1 Concentrated Animal Feed Operations (CAFO) and 34 medium Animal Feed Operations (AFO) that may meet the conditions of the draft general 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.

v. Federal Agriculture Farm Census

The Farm Census has been conducted by the Federal Department of Agriculture since 1997. Prior to that, it was conducted by the Department of Commerce from 1840 through 1996. Since 1976, the census has been conducted every five years and coincides with other economic censuses. The census provides facts and statistics about the nation's agricultural industry by state and county. Examples of some of the data collected includes crop production, livestock, poultry, machinery and equipment inventories, market values of land and buildings, farm expenses, sales, and other financial information. Data relevant to measuring changes in nitrogen loading were selected from the farm census. Table 3 is a comparison of data between the 1987 and 2007 census. Analysis of the 2012 census data is underway and a final report is expected early in 2014.

Table 3 - Federal Agriculture Farm Census Data, 1987 and 2007.

	1987	2007
Number of Farms	3,580	4,916
Acres of Farms	398,400	405,616
Total # of Cows	137,143	76,880
Total # of Swine	5,429	3,645
Total # of Poultry	4,913,031	Not Available
Manure used – acres	Not Available	30,017
Fertilizers & lime – acres	131,146	80,872
Organic production – acres	Not Available	1,485
Not harvested cropland – acres	6,353	12,597
Conservation farmland - acres	464	911

b. Groundwater

In areas found to contain excess levels of nitrogen in groundwater due to improperly functioning septic systems, CTDEEP has pursued the extension of public sewer service. Pine Grove serves as an example location where improperly functioning septic systems caused excess nitrogen loading to groundwater as well as created a nuisance for home owners. In the Pine Grove area, public sewer service was available for extension. In Old Saybrook, however, public sewer service was not available and CTDEEP worked with the town and homeowners to create an innovative approach to wastewater management that addresses the impact to groundwater. Both these projects are presented below in greater detail.

Pine Grove (Niantic) Sewering Project:

The USGS is conducting an evaluation of the effects on nitrogen loading due to sewering a densely developed residential area called Pine Grove and located in East Lyme, CT. Pine Grove is a peninsula located on the Niantic River estuary in southeastern CT. The area consists of 172 homes on approximately 35 acres. In 2004, the Town of East Lyme approved the installation of sanitary sewers as a wastewater management approach instead of the individual septic systems that residents relied upon. The project involved monitoring pre- and post-sewer groundwater nitrogen concentrations in order to estimate nitrogen loads to the estuary before and after installation of the sewers. Preliminary data indicates a decrease in nitrogen specifically in the shallow (30') and mid-depth (45') wells. The deeper (65') wells did not appear to be impacted by nitrogen.

Old Saybrook Decentralized Wastewater Management Program:

Under section 7-247 of the CGS, the town of Old Saybrook adopted an ordinance (8/11/09) to establish a decentralized wastewater management district for 1,900 properties located within the town. The ordinance has a set of wastewater treatment standards to which each property must be upgraded. Properties adjoining water bodies will be required to install advanced treatment (AT) units

designed to remove nitrogen to below 19 ppm prior to discharge into the ground. (Based on EPA Guidance for Federal Land Management in Chesapeake Bay Watershed, total nitrogen generally ranges from 40-50 mg/L for septic system discharges). Inland properties with sufficient land and adequate site conditions will be required to upgrade their onsite systems to a standard that exceeds current health code requirements. Inland properties without such resources will be required to install AT units in lieu of conventional onsite systems. Off-site treatment in a community or cluster system will be required where site conditions for both onsite and AT are infeasible. The project is being implemented in four phases, and is mandated by court order to be complete by December 2018. Funding for Phase I is being provided through the Clean Water Fund and involves upgrades at 360 properties. As of December 2012, 115 upgraded conventional systems had been installed. Completion of the work at all 360 properties is expected to occur by December 31, 2013.

c. Urban Non-regulated Stormwater

Many of CTDEEP's watershed management and nonpoint source programs address non-regulated stormwater. These programs are described in the below sections (d.i and d.iii). They include partnerships, technical assistance, and outreach to towns through UCONN's Nonpoint Education for Municipal Officials (NEMO), coastal site plan review, and the clean marina program to name a few. The Stormwater Quality Manual and Soil and Erosion Control Guidelines (with LID appendices) described above in section III are major technical outreach documents to address non-regulated stormwater sources.

d. State Programs

Coastal Management

The Coastal Management Act of 1979 requires that coastal site plan reviews filed with the zoning commission of municipalities located with the coastal jurisdiction be submitted to CTDEEP for consideration of potential adverse impacts of the proposed activity on coastal resources and future water-dependent uses (Section 22a-109). OLISP provides oversight to coastal municipalities and is responsible for review of coastal site plans and provides comments and suggested modifications for the proposed project to be compliant with the regulations.

In 1991, Connecticut passed two public acts (PA-170 & PA-398) both concerning the zoning regulations of municipalities adjacent to Long Island Sound. Any zoning regulations adopted by a town under PA91-170 or municipal plan of conservation and development prepared in accordance with PA91-398 shall be made with reasonable consideration for restoration and protection of the ecosystem and habitat of LIS and shall be designed to reduce hypoxia, pathogens, toxic contaminants, and floatable debris in LIS. Zoning regulations shall also require that the commission consider the environmental impact on LIS of any proposal for development.

Clean Vessel Act of 1992 – No Discharge Zone
The entire area of Long Island Sound is designated as a no discharge area for treated and untreated boat sewage. Connecticut sought no discharge approval from the EPA initially in the Stonington location. This location was approved in 2003, followed by the Mystic-Groton area (2004), then Groton through Guilford (2006), and Branford through Greenwich (2009). About 105 marine facilities provide boat pump-out services in CT. Those that receive grant funding report the total number of gallons pumped from boats per recreational season. For the 2010 season, approximately 619,735 gallons were reported by 37 facilities and 517,952 gallons for the 2011 season by 36 facilities. For 2012, approximately 581,103 gallons were reported by 41 facilities. Using this data and assuming a nitrogen concentration of 100mg/L for boat wastewater, an estimated 571 pounds, 433 pounds, and 485 pounds of nitrogen were prevented from entering LIS during 2010, 2011and 2012, respectively. These numbers are underestimated since data from all pump-out facilities was not available.

Clean Marina Program
Initiated in 2002, Connecticut's Clean Marina Program is a voluntary program that encourages inland and coastal marina operators to minimize pollution. The program recognizes Connecticut's marinas, boatyards, and yacht clubs that go above and beyond regulatory compliance as "Certified Clean Marinas." Marina's pledge yearly to participate and compliance is with the provisions of the industrial stormwater general permit. Due to resource restraints, CTDEEP is no longer accepting new pledges or recertifications.

Combined Sewer Overflows
Prior to 1990, Connecticut had 13 CSO communities (a total of 257 individual outfalls). As of 2011, 6 CSO communities remain (a total of 115, including CSOs at 6 WWTP). Unfortunately, volume reduction and cost estimates for the elimination of the 154 individual outfalls are not available. Out of the remaining 6 CSO communities, 4 are implementing long term control plans and 2 are secondary treatment bypasses. Since 1999, approximately, $137 million have been expended to address long term control plan design and implementation at the remaining CSOs. It is estimated that approximately $2.3 billion in total will be expended at these CSO communities over the next twenty years (forty years for Bridgeport). CT's progress towards CSO elimination/reduction is demonstrated in Table 4.

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.

On May 2, 2012, the Sewage Right to Know Act (Public Act 12-11) was signed by Governor Malloy. The law requires CTDEEP to notify the public whenever sewage overflows occur. It also requires CTDEEP to develop a static map of CSO locations to be posted on the agency's website. In the long term, a web based sewage spill reporting system interactive with public interface mapping will also be developed.

In an effort to reduce the stress of stormwater on combined sewers, CTDEEP is allowing for the use of Clean Water Fund money up to $300,000 for the implementation of green infrastructure. Additional funding may be secured if the CSO community can demonstrate the benefit in CSO reductions.

Table 4 - Progress towards CSO elimination in CT.

Community	1970s	1990s	2004	2005	2006	2010	2011
Bridgeport	78	68	44	44	40	36	32
Derby	10						
Enfield	6	1	1	1	1		
Jewett City	2						
MDC	49	44	36	36	36	36	37
Middletown	13	1	1	1	1	1	
New Haven	34	32	31	31	31	31	29
Norwalk	3	1	1	1	1	1	1
Norwich	35	15	15	15	15	15	15
Portland	1						
Shelton	10	1	1	1	1		
Waterbury	10	1	1	1	1	1	1
Westport	6						
# CSO Communities	13	9	9	9	9	7	6
Total Outfalls	257	164	131	131	127	121	115

Onsite Wastewater Management

Regulation of onsite wastewater systems that discharge greater than 5,000 gallons per day, include alternative treatment, and community systems fall under CTDEEPs purview. This excludes residential septic systems which tend to discharge less than 2,000 gallons per day. In Connecticut, residential septic systems are managed by local municipalities or regional health districts in accordance with delegations in state law and public health code (Section 19-13-B100a). Onsite wastewater treatment systems that are less than 5,000 gallons and greater than 2,000 gallons are regulated by the Connecticut Department of Health.

Conventional treatment septic systems that existed prior to May 19, 2012 may renew their permits through a general permit process. This includes registration and completion of a wastewater management plan (with two years of registering).

The plan includes a monitoring and maintenance schedule, as well as the current status of the system and any future plans. Requirements of individual permits are site specific and typically include groundwater monitoring and analysis for bacteria, pH, TDP, and nitrogen species (ammonia, nitrate, nitrite, TKN, total), pump-out and inspection schedule, and process monitoring (for alternative treatment systems).

The 1990 census data indicated that about 385,309 of the 1.32 million Connecticut households managed sanitary waste with septic systems and other options (including chemical toilets and outhouses). In other words, approximately 29.1% of households in Connecticut used septic systems at the time of the 1990 census. At the time of the 2010 census, approximately 38.3% of households used septic systems (570,000 out of 1.49 million). Although, the amount of households using septic systems increased over the twenty year period, CTDEEP and local municipalities have made advances in sewering areas known to have poorly drained soils, high water tables, or other conditions contributing to improperly functioning septic systems. Those areas include, but are not limited to Pine Grove and Old Saybrook discussed above in section c.

Air Nitrogen Controls

CT DEEP maintains a diverse air program which includes monitoring, permitting, planning, and inventorying sources that contribute six criteria pollutants. These pollutants are ozone, nitrogen dioxide, particulate matter, sulfur dioxide, carbon monoxide, and lead. Nitrogen dioxide (NO_2) is of particular concern to CTDEEP since it forms quickly from emissions from cars, trucks, buses, power plans, and off-road equipment and contributes to the formation of ground-level ozone. Also, it is considered an indicator for the larger group of nitrogen oxides (NOx).

A variety of federal and state NOx control programs have been implemented over the last twenty plus years to address air quality concerns such as ozone, fine particulate matter, and regional haze. Regulations specific to air controls are included in Section 22a of the Regulations of Connecticut State Agencies (RCSA). Those regulations that address the control of NOx specifically are presented in Table 5.

Table 5- Regulations of Connecticut State Agencies specific to atmospheric NOx controls.

Title	Section	Adopted/Revised
Control of nitrogen oxide emissions	RCSA 22a-174-22	1972 (19-508-22 Administrative Regulations) /1994, 1997, 2000, 2004, 2006
The Nitrogen Oxides (NOx) Budget Program	RCSA 22a-174-22a	1999 Repealed 2007
Post-2002 nitrogen oxides (NOx) budget program	RCSA 22a-174-22b	1999/2006 Repealed 2010
CAIR NOx ozone season trading program	RCSA 22a-174-22c	2007/2010
Improvements in the control of particulate matter and visible emissions	RCSA 22a-174-18	1972 (19-508-18 Administrative Regulations) /2004
Connecticut enhanced vehicle inspection and maintenance program	RCSA 22a-174-27	1982 (19-508-27 Administrative Regulations) /2009
CT's California low emission vehicle phase 2 (CALEV2) [1]	RCSA 22a-174-36b	2004/2012
Reductions in NOx emissions from municipal waste combustors (Phase 2)	RCSA 22a-174-38	1999/2008
NSR permit to construct and operate stationary sources	RCSA 22a-174-3a	2002/2012

1 = Connecticut is implementing a third phase of low emission vehicle standards mirroring those adopted in California (CALEV3) for the 2015 model year.

The air regulations were initially adopted in 1972, however many sections have undergone a number of revisions and new sections have been added over the last 20 years or so. Many sections from the air regulations have been incorporated into permit requirements. However, since air permits address point sources and this evaluation is not aimed at point source controls, the remainder of this section will explore monitoring and tracking of ambient NO_2. Once NO_2 is deposited on the ground, it contributes to the stormwater nitrogen load.

CTDEEP collects ambient air quality data for the six criteria pollutants at a network of monitoring stations located across the state. Monitoring for NO_2 occurs at four stations located in Cornwall, East Hartford, New Haven, and Westport. The following figure illustrates the annual design value NO_2 results from since 1983 to 2010. Nitrogen dioxide has been well below the annual

National Ambient Air Quality Standard (NAAQS) of 53 ppb established by EPA in 1971 (Figure 6).

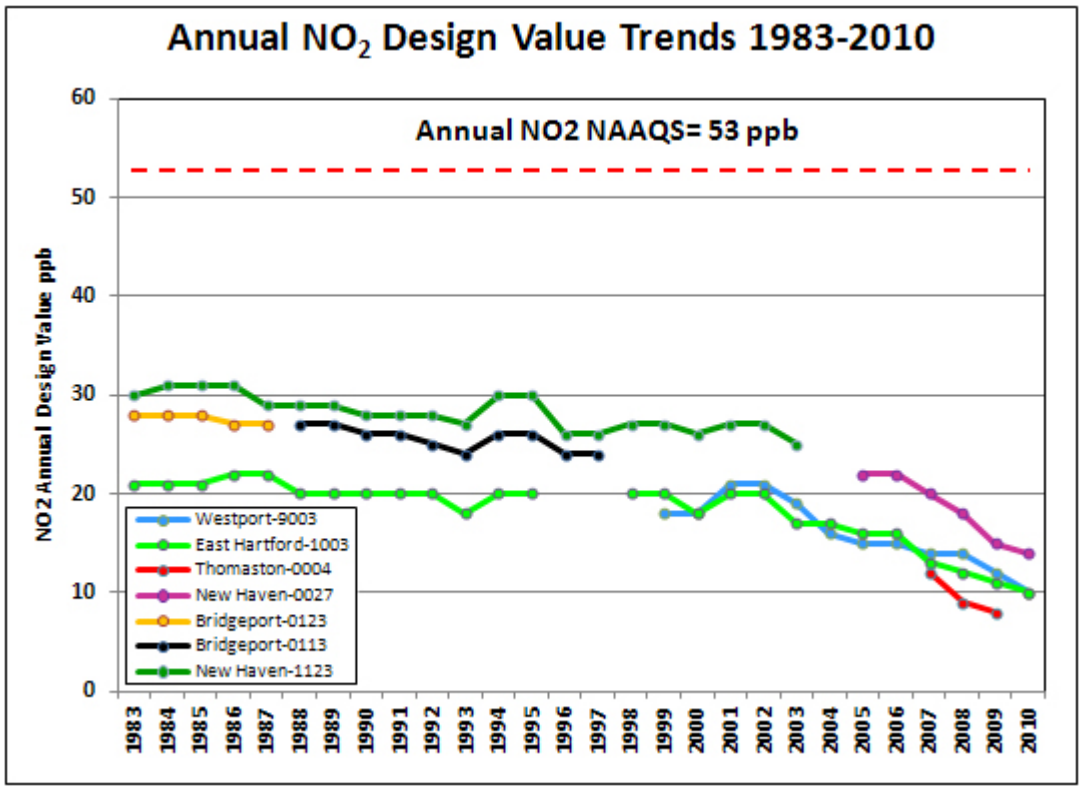


Figure 6 - Nitrate trends in ambient air monitoring at various locations.

Although EPA's NO_2 standard was derived to be protective of human health, the decrease in NO_2 would have a secondary benefit on stormwater quality and subsequently, the nitrogen load to LIS. The decrease in the annual design value NO_2 is likely the result of environmental regulations combined with economic factors (such as the decreased use of coal plants due to the increase in natural gas usage by consumers). Although Connecticut has realized a decrease in the ambient NO_2 concentration, it remains concerned with the transport of atmospheric nitrogen and other air contaminants across state borders. Nitrogen oxide emissions transported from upwind states are the primary cause of unhealthy ozone levels that occur during the summer in Connecticut. EPA modeling has shown that more than 90% of maximum ozone levels in some portions of Connecticut can be attributed to transported emissions from upwind areas (Bodner, CTDEEP, Pers. Comm.).

Nonpoint Source (NPS) Program

The CTDEEP's Nonpoint Source (NPS) Program works to abate known water quality impairments and prevent significant threats to water quality from nonpoint source pollution. A significant strength of the program is its networked approach

to nonpoint source management. CTDEEP has formed strong partnerships with a wide range of public agencies, industry organizations, and private groups to implement nonpoint source management. Connecticut's NPS Program is well balanced, with an appropriate mix of statewide programs and geographically targeted watershed projects. The state NPS Program includes all the components required under the federal Clean Water Act (CWA) Section 319(h) (US EPA Nonpoint Source Management Programs), from which it receives yearly funds to support projects and program staff. CTDEEP's Bureau of Water Protection and Land Reuse (BWPLR) administers grants to local and regional organizations for planning and implementation of NPS programs. CTDEEP uses Section 319 funding allocations to support NPS Program staff and to fund projects primarily targeted to impaired watersheds (i.e., not meeting state water quality standards), focusing on the Watershed Based Plans (WBP) and implementing best management practices in prioritized in those watersheds in CT (see Appendixes A and B).

Watershed Plans and other Nonpoint Source Management Tools

CTDEEP created the watershed management program in 1996 to increase efficiency in water resources management by incorporating an integrated holistic perspective. The outreach website can be viewed at: http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325624&depNav_GID=1654#WatershedCoordinators. The website includes links to information about nonpoint source pollution, watershed management, and steps to preparing watershed plans just to name a few. Access to watershed management plans and relevant documents is provided. The site also includes a current map (Figure 7) of the three phases of watershed activities occurring in Connecticut. This map tracks the status of watershed activities as capacity, planning, and implementation.

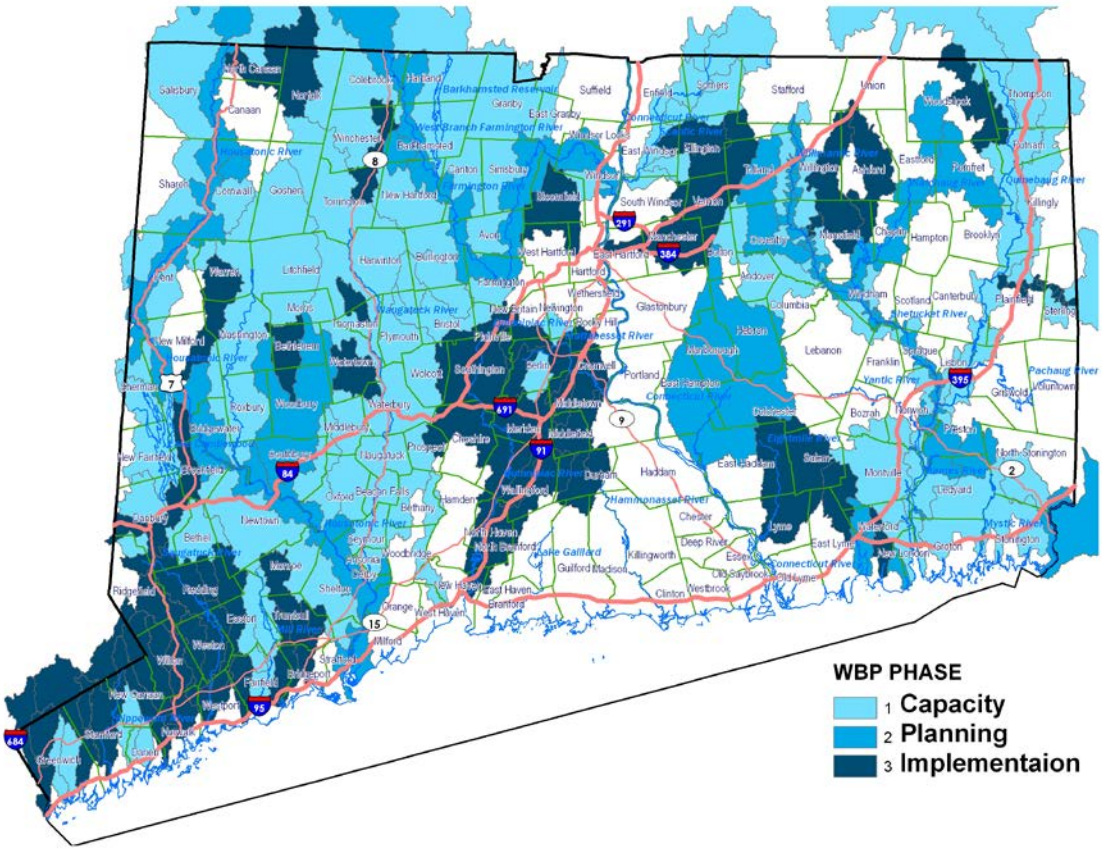


Figure 7- Three phases of watershed activities.

Definitions:

Capacity – DEEP partnerships have been established for a holistic, coordinated effort toward NPS planning and implementation in the watershed.

Planning – DEEP has coordinated with established Capacity and drafted or finalized an EPA approved 9 Element Watershed Based Plan or other watershed management plan.

Implementation – DEEP has partnered or supported Capacity in a watershed for the successful implementation of projects described or outlined in Watershed Based Plans or other watershed management plans during the Planning process.

CTDEEP's website also hosts a number of documents that demonstrate the diversity of CT's efforts to address nonpoint source pollution through stormwater management. Some of these documents include:

- Evaluation of Connecticut's Stormwater General Permits and Alternatives for Incorporation of Low Impact Development, May 2011 http://www.ct.gov/deep/cwp/view.asp?a=2719&q=459488 (Discussed above in Section III). Other LID tools are included at this web address.

- Best Management Practices for Water Quality While Harvesting Forest Products, DEP 2007
http://www.ct.gov/dep/cwp/view.asp?a=2697&q=379248&depNav_GID=1631.
This booklet was published by the CTDEEP to assist certified forest practitioners, private landowners, and municipal officials towards a better understanding of the BMPs associated with the harvest of forest products.

- Environmental BMP Guide for Small Businesses, DEP 2009
http://www.ct.gov/deep/lib/deep/compliance_assistance/manuals_guidelines/bmpforsmallbsiness.pdf . This CTDEEP publication summarizes BMPs for storm water, pesticides and fertilizers, and waste in a four page brochure.

- Best Management Practices for Golf Course Water Use, DEP 2006
http://www.ct.gov/dep/lib/dep/water_inland/diversions/golfcoursewaterusebmp.pdf. The best management practices document for golf course water use is intended to promote water conservation, preserve or improve water quality, and protect water resources. BMPs included in the document were developed by a work group consisting of superintendents, environmental regulators, and specialists from local engineering, scientific, and irrigation consulting groups. They were developed for the use of golf course planners, architects, developers, and local regulators who may need assistance and guidance in developing new golf courses, or making changes to existing golf courses, under the regulatory and environmental constraints that exist in the State of Connecticut. Since 2007, Golf courses that obtain a diversion general permit (DEP-GP-001R, DEP-IWRD-GP-011, DEP-IWRD-GP-012) must conform to the document. Individual permits for golf courses include a stipulation that "the permitee shall employ best management practices to control storm water discharges, prevent erosion and sedimentation, and to otherwise prevent pollution of wetlands and other waters of the State".

- Good Horse Keeping – Best Practices Manual for Protecting the Environment, 2011
http://easternrcd-ct.org/HEAP/GOODHORSEKEEPINGBMP-PROOF3.pdf.
This manual was developed by the Horse Environmental Awareness Program (HEAP). HEAP is a coalition of federal, state and local agencies, organizations and individuals that meet regularly to discuss and provide educational assistance to equine owners. The purpose of this manual is to provide equine owners/managers with a handbook on installing/managing BMPs to protect the environment.

- Manual of Best Management Practices for Agriculture, 1996 revision
http://www.ct.gov/deep/lib/deep/aquifer_protection/bmps_agriculture.pdf. This manual was prepared to provide guidance in the development of farm resources management plans for agricultural operations. The manual consists of standards

and specifications for agricultural BMPs to prevent, abate, or minimize pollution of surface and groundwater.

- Feasibility Study for Alternative Technologies and Utilization for Managing Dairy and Poultry Manure, 2005
http://easternrcd-ct.org/NutrientManagement/NMpdfs/CAFOFeasibilityStudy.pdf
This report evaluates a variety of alternatives to address the current State nutrient surplus. The ultimate goal of this project is to identify economically and technically feasible manure management methods for the dairy and poultry industry that would effectively manage surplus nutrients produced by CAFOs located throughout the State of Connecticut.

Inland Wetlands and Watercourses Act
Connecticut has a long history of protecting its water and land resources. In 1972, the state legislature enacted the Inland Wetlands and Watercourses Act (IWWA, sections 22a-36 through 22a-45 of the General Statutes of Connecticut), which requires the regulation of activities affecting the wetlands and watercourses of our state. The Wetlands Management Section of CTDEEP provides oversight, training, regulatory, and technical assistance to Connecticut's municipal inland wetlands agencies. Each town's municipal inland wetlands agency regulates activities that affect inland wetlands and watercourses within their municipal boundaries. State agency actions are solely regulated by the CTDEEP. Over 4,000 actions (such as permit approvals or denials, enforcement proceedings, etc.) are taken by Connecticut's municipal inland wetlands agencies annually. Pursuant to the Act, municipal inland wetlands agencies must report to CTDEEP each action taken and annual reports are compiled by CTDEEP. In 1997, Guidelines for Upland Review Area Regulations was published in accordance with CGS sections 22a-42(d) and 22a-42a(f) to assist municipal inland wetland agencies in developing and implementing regulations for activities proposed on upland riparian areas around wetlands or watercourses. The guide was drafted for wetland agency members, river management groups, the regulated community, and other interest persons, for assistance in implementing what are popularly called buffer or setback provisions in wetland regulations. Although land use change in riparian areas shows steady pressure to develop in proximity to river and stream more intensive control of those activities now takes place.

Landscape Stewardship Initiative
Connecticut's landscape stewardship initiative is an important part of the Governor's responsible growth executive order 15 signed in 2006. The goal of this initiative is to coordinate and focus the Department's many programs that influence land development through outreach to local land use boards and commissions; federal, state, and local officials; regional planning agencies; councils of government and councils of chief elected officials; private developers; non-government organizations; and interested local citizens. Resource information such as financial assistance and grants, brownfields regulations, maps

and GIS data, open space, and CTDEEP plans that related to landscape stewardship have been made available on the department's website. As part of this program, CTDEEP released *The Municipal Primer – Your Guide to Creating a "Green and Growing" Community* (the Municipal Primer) in 2008. This manual provides basic information and guidance to municipal officials on a wide variety of topics related to environmental protection so that local decision-makers are informed about key environmental topics. From land use decisions, to purchasing practices, to the operation of municipal facilities, and more, the Municipal Primer provides municipal officials with a tool that allows them to quickly determine which CTDEEP programs relate to any given situation and identifies sources of additional information, including web pages and staff contacts.

UCONN Center for Land Use Education and Research (CLEAR) & Nonpoint Education for Municipal Officials (NEMO)
CLEAR and NEMO provide information, education and assistance to land use decision makers, community organizations, and citizens about the relationship between land use and natural resources, particularly nonpoint source pollution and water quality. Both CLEAR and NEMO promote responsible land use activities by providing training and resource information hosted on their website. In past years, CLEAR has tracked the implementation and incorporation of Low Impact Development (LID) activities. The LID atlas provides geo-referenced examples of stormwater management activities across Connecticut. A total of 80 LID projects are hosted on the website, however, population of the inventory relies on self-reporting and therefore, should be considered incomplete. The CLEAR website indicates that nine towns have adopted LID requirements into their zoning and/or sub-division regulations. This information has only been updated through 2008. It is expected that additional towns have also adopted LID requirements.

UCONN Cooperative Extension System
Manages an outreach effort called "Water Quality and the Home Lawn" which educates and trains residents to reduce water quality risks in and around the home. Programs incorporate regional and national research results from septic systems and well water, nutrient and pesticide management, landscape management, and plant selection.

UCONN Integrated Pest Management/Turf Management Program
A number of diverse outreach and education efforts targeted at the residential, commercial, and agricultural communities. This program conducts training regarding appropriate application rates for pesticides and nutrients. They also conducted targeted pesticide and nutrient reduction projects within specific watersheds. For example, an integrated pest/crop management project in the Quinnipiac River watershed resulted in a 63% reduction of pesticide active

ingredient on 785 acres; and a 32% (42,117 pounds) reduction for nitrogen on 376 acres.

Department of Agriculture Bureau of Aquaculture
The Connecticut Bureau of Agriculture, Division of Aquaculture (DA/BA) conducts sanitary surveys along the shoreline for complete coverage of the entire shoreline every twelve years. The surveys consist of bacteria measurements, visual observations, and the identification of actual and potential pollution sources. Although, DA/BA's focus is the protection of shellfish resources, the primary pollution sources that are detected through these may contribute some amount of nonpoint source nitrogen to LIS. Some examples of pollution sources include improperly functioning septic systems, illicit sanitary discharges, and failure to the sanitary sewer conveyance system. All identified problems are referred to the local health departments for corrective action. DA/BA reevaluates the findings of the sanitary survey on an annual and triennial basis.

Department of Transportation
In 2004 when the Connecticut DEP initiated preparation of the MS4 permit, the CTDOT prepared a stormwater management plan (SWMP) for the purpose of establishing, implementing and enforcing a stormwater management program to reduce the discharge of pollutants from the CTDOT's highways, roadways, railways and facilities to the maximum extent practicable. The purpose of the plan is to protect water quality and to satisfy the appropriate requirements of the Clean Water Act. Although not subject to the MS4 permit at this time, the CTDOT continues to operate under the SWMP.

The SWMP covers all of the department's highways, roadways and railways located within Urbanized Areas (UA) as indicated by the 2000 Census. Additionally, all interstate highways within the state are covered under this SWMP regardless of location. Individual facilities such as airports, maintenance garages, ports, salt sheds and other miscellaneous facilities are covered under other stormwater general permits with CTDEEP.

The plan outlines a program of best management practices (BMPs) and measurable goals for the following six minimum control measures specified in the NPDES Phase II program.

- Public education and outreach,
- Public participation/involvement,
- Illicit discharge detection and elimination,
- Construction site runoff control,
- Post-construction runoff control, and
- Pollution prevention/good housekeeping

For each minimum control measure, the CTDOT has defined appropriate BMP's, designated a person(s) and job title responsible for each BMP, defined a time frame for implementation of each BMP, and defined measurable goals for each BMP. The CTDOT continues to report on their activities under the SWMP to CTDEEP annually. In addition, CTDOT has reduced its use of nitrogen containing fertilizers to only new installations of grass and plantings.

e. Local Projects

Municipal Soil Erosion and Sediment Control
Connecticut's Soil Erosion and Sediment Control Act (1983) established a public policy to strengthen and extend its erosion and sediment control activities and programs and to establish and implement a statewide coordinated erosion and sediment control program which shall reduce the danger from stormwater runoff, minimize non-point sediment pollution from land development and conserve and protect the land, water, air, and other environmental resources of the state. In regards to local municipalities, the Act required:

- Municipal planning and zoning commissions to amend their regulations to make proper provisions for soil erosion and sediment control, mandating the submission and certification for adequacy of erosion and sediment control plans in applications before them where the disturbance of land is greater than one half acre.

Also provided within the act were model guidelines for municipal regulations that may be used by municipalities to comply with the Act. The model guidelines were revised and included in the 2002 Guidelines for Soil Erosion and Sediment Control manual.

Local BMP efforts
A number of towns require the implementation of best management practices or LID techniques for development projects. In fact, since it was released in 2002, the Guidelines for Soil Erosion and Sediment Control have been incorporated into local town regulations. However, no centralized database of BMPs exists for Connecticut. In 2009 & 2010, Dr. Shimon Anisfeld of Yale University, conducted a study which included a survey of twenty-two towns, South Central Regional Water Authority, and Milone and MacBroom. He compiled a list of approximately 60 sites that included stormwater ponds and wet ponds. Eight of those sites became the subject of study "Efficiency of Standard Stormwater BMPs for Nitrogen Removal" (see Section g i below). Also, the University of Connecticut's Center for Land Education and Research (CLEAR) has tracked the implementation and incorporation of LID activities. The LID inventory provides geo-referenced examples of stormwater management activities across Connecticut. A total of 80 LID projects are hosted on the website, however, population of the inventory relies on self-reporting and therefore, should be

considered incomplete. The CLEAR website indicates that nine towns have adopted LID requirements into their zoning and/or sub-division regulations. This information has only been updated through 2008. Since then, it is expected that additional towns have also adopted LID requirements.

CTDEEP has knowledge of one town that has overseen the installation of approximately 40 swirl concentrators by both public and private entities during facility expansions as well as new development. The installation of stormwater controls is recommended by Conservation, and Building and Zoning during site plan review. Installation of the first swirl concentrator was supported by a 319 grant.

f. Other

Population Dynamics
Population data for the State of Connecticut was obtained from the United States Census Bureau. The bureau conducts a survey of every resident in the United States every ten years. Data is available by state and the bureau also provides population change and density for every ten years of data beginning in 1910. In 1980, the population count in Connecticut was 3,107,578. By 1990, the population increased 5.8% to 3,287,118. The 2000 census revealed that the population increased 3.6% to 3,405,585 and in 2010 the increase was 4.9% to 3,574,097. Population data for Connecticut indicates a steady increase with an overall increase of 8% (286,979 people) between 1990 and 2010. The change in population between 2000 and 2010 was greatest in the Lower Connecticut River, Quinebaug, Shetucket and Thames basins. Connecticut ranks sixth in population density (a measure of the average population per square mile).

g. Grant Funded Projects

i. Efficiency of Standard Stormwater BMPs for Nitrogen Removal (2010)
This project was funded by the Long Island Sound License Plate Fund and conducted by Dr. Shimon Anisfeld of Yale University. The study consisted of an evaluation of MS4 data, collection of additional MS4 data, and sampling at eight wet ponds located in the greater New Haven area. The results identified the variability in MS4 data and found that the greatest nitrogen reductions can be achieved by implementing BMPs in areas with the highest concentrations. Removal efficiencies for nitrate ranged from 35-65%, and 29-44% for total nitrogen. The results of this study may be useful in planning nitrogen reduction projects.

ii. 319-Funded Projects
CTDEEP conducted a review of 319-funded projects through the Grant Reporting and Tracking System (GRTS). Projects with specific nitrogen

reductions (1990 through present) were tallied from the following project categories.

- Animal Manure/Litter Management
- BMP Design/Implementation
- Erosion Control Projects
- Livestock Control Projects
- Livestock Grazing System Planning
- Nutrient Management Planning
- Other Restoration/Protection/Prevention
- Sediment Control
- Stormwater Discharge Design/Control
- Stormwater Management Planning
- Stream Bank Stabilization
- TMDL implementation
- Technical Assistance to State/Local

The results include projects dated 2003-2009. A query for years 2010 and 2011 found that project explanations and data were not detailed and those projects with titles that indicated nitrogen reductions did not have a reduction specified in GRTS.

Table 6 - Estimated nitrogen reductions from the GRTS database.

Project ID	Project Name	Nitrogen lbs/yr
2003-08	AFO-CAFO Nutrient Management	10,714
2003-15	Mattabassett Watershed Plan Implementation	43
2003-21	Beebe Hill Stormwater & Erosion	19,763
2003-27	Gilbert and Bennett Brook Restoration	4
2003-32	WQ Improvements Day Street/Westview Drive, Brooklyn	304
2004-02	AFO-CAFO Nutrient Management	3,832
2004-18	Mattabassett Watershed PlanStream Restoration 12	2
2005-01	AFO-CAFO Nutrient Management	29,722
2005-04	Reduced Pesticide Nutrient Loading - Thames	1,509
2005-08	NPS Watershed Management Support	44,959
2005-13	Mount Hope River Stream Restoration	265
2005-16	French River Riparian Buffer - Thompson	18
2006-01	AFO-CAFO Project Series	
2006-01a	Quinnebaug	5,564
2006-01b	Lower Connecticut	8,815
2006-01c	Housatonic	11,680
2006-01d	Farmington	205
2006-01e	Thames	3,648
2006-01f	Shetucket	2,723
2006-04	IPM/ICM	1,256
2006-14	ECCD - Farm Nutrient Reductions	23,330
2007-01	AFO-CAFO Project Series	64,306
2007-04	NPS Management/Watershed Protection	15,767
2007-07	Fenton River Horse Farm BMPs	16
2007-10	IPM/Nutrient Mgt. Demonstration	3,984
2007-11	North Canaan Dairy Manure Composting	101
2007-12	Norwalk River Watershed Goose Mgt.	82
2007-14	Eagleville Brook Green Roof	1
2007-15	Nitrogen Fertilizer Reductions Coastal Education	2,706
2007-16	Spaulding Pond WQ Improvement	4
2008-10	Nitrogen Fertilizer Reductions Coastal &Inland Waterway Lawns	3,596
2008-12	North Canaan Dairy Manure Composting Phase 2	10,455
2009-04	ECCD - Hockanum/Little River Watershed Mgt	1,302
2009-07	ECCD - Tree Filters Latimer Brook/Park Rvr North	142
2009-08	Fenton River Horse Farm BMPs Year 2	16
2009-10	North Canaan Nutrient Removal System	10,455
	TOTAL	281,289

h. GIS mapping

The UCONN's Center for Land Use Education and Research (CLEAR), mentioned in c(ii) above, has conducted several projects to measure change in land cover, riparian corridors, and impervious surfaces using imagery from 1985 and continuing every five years (roughly) through 2010. These analyses are based on Landsat imagery taken at 100 foot (30 meter) squares or pixels resolution scales.

Recently, CLEAR completed a land cover change analysis for Connecticut and the portion of New York that drains to LIS for the 1985-2010 time period. Land cover refers to what is physically on the ground, such as grass, developed and forested land. The analysis includes 12 major land cover categories. A summary of land cover change in Connecticut is presented in Table 7 and the information is graphically displayed in Figure 8.

Table 7 - Land Cover in Connecticut 1985-2010 and change.

	1985			2010			Change		
	acres	sq. miles	%	acres	sq. miles	%	acres	sq. miles	%
Developed	505819	790.3	16.1%	600701	938.6	19.1%	94882	148.3	3.0%
Turf & Grass	195695	305.8	6.2%	243285	380.1	7.7%	47590	74.4	1.5%
Other Grass	41427	64.7	1.3%	60732	94.9	1.9%	19305	30.2	0.6%
Ag. Field	269431	421.0	8.6%	229338	358.3	7.3%	-40093	-62.6	-1.3%
Deciduous Forest	1563740	2443.3	49.6%	1459510	2280.5	46.3%	-104230	-162.9	-3.3%
Coniferous Forest	289009	451.6	9.2%	278844	435.7	8.9%	-10165	-15.9	-0.3%
Water	111010	173.5	3.5%	103569	161.8	3.3%	-7441	-11.6	-0.2%
Non-forested Wetlands	12742	19.9	0.4%	13055	20.4	0.4%	313	0.5	0.0%
Forested Wetlands	115994	181.2	3.7%	110006	171.9	3.5%	-5988	-9.4	-0.2%
Tidal Wetlands	13971	21.8	0.4%	14136	22.1	0.4%	166	0.3	0.0%
Barren	19444	30.4	0.6%	25408	39.7	0.8%	5964	9.3	0.2%
Utility ROW (Forest)	11250	17.6	0.4%	10918	17.1	0.3%	-331	-0.5	0.0%

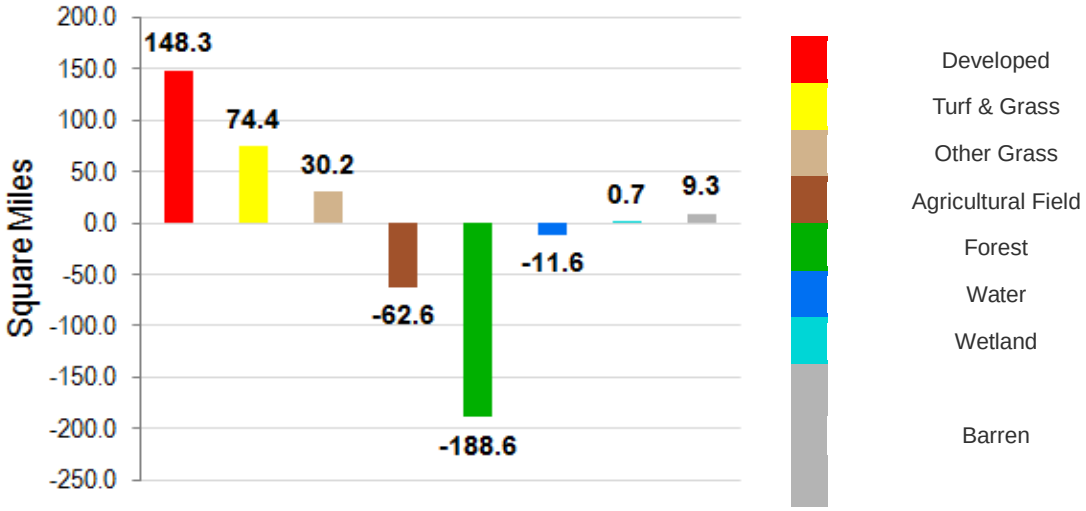


Figure 8 - Graphic display of major land cover type change between 1985 and 2010.

According to CLEAR's land cover change analysis, developed land in Connecticut increased by 148.3 square miles. Cover categories, turf & grass and other grasses, associated with developed land also increased by 74.4 and 30.2 square miles, respectively. Conversely, forest and agriculture lands decreased by 188.6 and 62.6 square miles, respectively.

CLEAR provides maps and information organized by the watershed level referred to as the Hydrologic Unit Code (HUC) 12 and 8. The HUC hierarchical system of watershed organization was created by the United States Geological Survey (USGS). Land cover change, riparian corridors, and impervious surfaces data for Connecticut's HUC 8 watersheds (major basins) are provided in Appendix D of this report.

Riparian Corridors

Using the imagery datasets from the land cover change study (1985-2006), CLEAR evaluated the change in developed areas that occurred within the 300 foot and 100 foot riparian corridors across Connecticut. Riparian refers to the land immediately adjacent to water bodies such as streams, ponds, and lakes. The results indicate that the greatest change in developed area occurred within 300 feet of a stream or river resource (Table 8). Only about 0.7 percent of the change in developed area occurred outside of riparian corridors. The final report can be accessed at http://clear.uconn.edu/publications/research/Statewide_riparian_final.pdf

Table 8 - Change in percent developed land within the 100 ft and 300 ft corridors, compared to statewide change.

	1985	2006	Change in %
100 ft corridor	12.7%	14.4%	1.7%
300 ft corridor	14.5%	16.8%	2.3%
entire state	16.0%	19.0%	3.0%

This study was recently updated to include the 2010 Landsat imagery as well as the portion of New York that drains to LIS. However, the study was restricted to only one predefined distance from the stream (300 feet). This distance was chosen as it was determined that the imagery resolution was not great enough to generate meaningful data for the 100 foot interval. A summary of riparian zone land cover change in Connecticut is presented in Table 9 and the information is graphically displayed in Figure 9.

Table 9 - Land cover change within the riparian zone in Connecticut 1985-2010.

	1985			2010			Change		
	acres	sq. miles	%	acres	sq. mi	%	acres	sq. miles	%
Developed	121924	190.5	14.5%	141284	220.8	16.8%	19360	30.3	2.3%
Turf & Grass	43311	67.7	5.1%	53499	83.6	6.4%	10187	15.9	1.2%
Other Grass	10748	16.8	1.3%	16107	25.2	1.9%	5359	8.4	0.6%
Ag. Field	59110	92.4	7.0%	52428	81.9	6.2%	-6682	-10.4	-0.8%
Deciduous Forest	417272	652.0	49.6%	396673	619.8	47.1%	-20599	-32.2	-2.4%
Coniferous Forest	84207	131.6	10.0%	82218	128.5	9.8%	-1989	-3.1	-0.2%
Water	25526	39.9	3.0%	20916	32.7	2.5%	-4610	-7.2	-0.5%
Non-forested Wetlands	7055	11.0	0.8%	7306	11.4	0.9%	251	0.4	0.0%
Forested Wetlands	61663	96.3	7.3%	58634	91.6	7.0%	-3028	-4.7	-0.4%
Tidal Wetlands	3005	4.7	0.4%	3107	4.9	0.4%	102	0.2	0.0%
Barren	4865	7.6	0.6%	6578	10.3	0.8%	1713	2.7	0.2%
Utility ROW (Forest)	2901	4.5	0.3%	2836	4.4	0.3%	-65	-0.1	0.0%

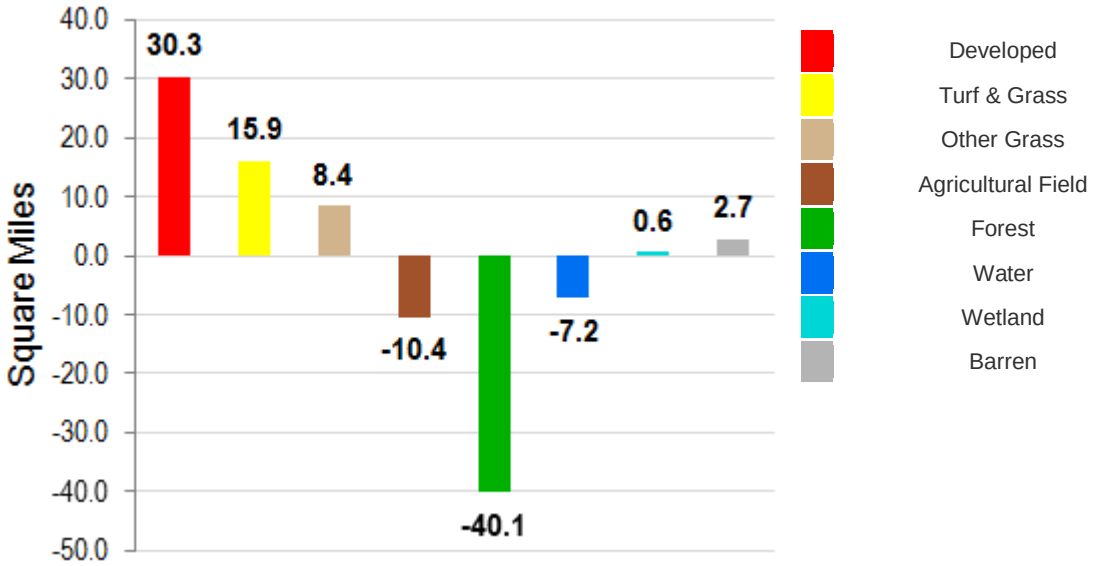


Figure 9 - Graphic display of land cover change within the riparian zone between 1985 and 2010.

Based on the riparian land cover change analysis, developed land within 300 feet of a water body increased by 30.3 square miles. This represents approximately 20% of the overall developed land cover increase. Turf & grass and other grass categories also increased by 15.9 and 8.4 square miles, respectively. Forest, agriculture, and interestingly water land cover categories all decreased by 40.1, 10.4, and 7.5 square miles, respectively.

Impervious Surfaces

Funded by the Long Island Sound Study, the objective of this project was to document change in impervious surfaces over time (1985-2002). Impervious surfaces include the human made structures, such as roofs, roads, and parking lots. Research has found a positive correlation between the percent of impervious surfaces and water quality degradation. In other words, as urbanization increases there is a decrease in the amount of stormwater infiltration to the ground, an increase in the amount of stormwater runoff, and a subsequent increase in contaminations carried to nearby rivers and streams. The LIS study area experienced an increase in developed area and, as to be expected, an increase impervious surfaces as well (Tables 10 and 11). The project completion report can be accessed at http://clear.uconn.edu/projects/imperviouslis/pdfs/LISS_Impervious_Surfaces_Final_Report.pdf

Table 10 - The amount of developed area increase from 1985 to 2002.

	Total Area	Developed Area				% Increase 1985-2002
		1985	1990	1995	2002	
Connecticut	3,296,015	527,277	569,153	583,042	605,709	14.87
New York	306,052	158,762	160,958	161,973	163,038	2.69
LIS Study Area	3,602,067	686,039	760,111	745,015	768,747	12.06

Table 11 - The percent of impervious surface over the study period and overall percent increase.

	% Impervious Surface				% Increase 1985-2002
	1985	1990	1995	2002	
Connecticut	6.13	6.75	7.06	7.46	21.7
New York	31.68	32.68	33.31	34.17	9.53
LIS Study Area	8.30	8.95	9.29	9.73	17.23

This impervious cover study was also recently updated to include the 2010 Landsat imagery. Impervious cover is not reported by state but is presented by watershed (i.e. HUC 8). A summary of impervious cover increase is presented in Table 12. The complete results for each major basin at five year intervals are included in Appendix D.

Table 12- Impervious cover increase over 25 years for HUC 8 basins.

Basin	1985		2010		Change	
	acres	%	acres	%	acres	%
Farmington	15276	2.3	17381	2.6	2105	0.3
Housatonic	44256	6.6	49661	7.4	5405	0.8
Lower CT	48488	7.2	55244	8.2	6756	1.0
Quinebaug	16976	2.5	20008	3.0	3032	0.5
Quinnipiac	33127	4.9	36567	5.4	3440	0.5
Saugatuck	34345	5.1	36391	5.4	3046	0.3
Shetucket	12596	1.9	14370	2.1	1774	0.3
Thames	13296	2.0	15585	2.3	2289	0.3

The greatest increase in impervious cover over the twenty-five year period occurred in the Lower Connecticut River basin. Consequently, the developed land category for this basin increased by 4%, this is the second greatest increase in developed land among the eight basins. The Quinnipiac basin experienced the greatest increase in developed land at 4.1%. However, the increase in impervious surfaces was 0.5%, half that of the Lower Connecticut River basin. Developed

land in the Thames River basin increased by 3.6% but the impervious cover increase is among the lowest of the eight basins. Therefore, it is difficult to distinguish a clear relationship between increases in developed land and increases in impervious cover. CLEAR notes that the developed land cover category and impervious cover are closely related but they are not identical.

It is also important to note that the greatest increase in population between 2000 and 2010 occurred in the Lower Connecticut River basin. Interestingly, this increase is population seems to correlate with increases in the developed and turf and grass land cover categories, as well as impervious cover.

Forest Fragmentation
CLEAR applied a fragmentation model to the 1985-2006 land cover dataset in order to better evaluate the details of forested areas. Forested land was sorted into four main categories (core, perforated, edge, and patch in order of least disturbed to most disturbed). During the twenty-one year study period, Connecticut lost 3.7% of forest or about 185 square mile to other land cover categories, predominantly developed. In addition, 79 square miles of core forest was converted to more disturbed categories, namely perforated and patch. A summary of this project can be accessed at http://clear.uconn.edu/projects/landscape/forestfrag/forestfrag_public%20summary.pdf

i. Relative Change in Scope and effectiveness of program from 1990 to present
Following establishment of the Watershed Management Section (1996), programs relating to nonpoint source and stormwater controls have increased considerably. Appendix E includes a timeline of major water management programs administered by the state. Although a few NPS/stormwater programs were initiated in the 1980's, most of the programs commenced in the 1990's. Many of the programs, such as 319 grant projects and watershed planning involve partnerships with other state agencies, local municipalities, nonprofit organizations, and other individual stakeholders. These partnerships have proven effective not only in planning but also in maintaining the momentum towards clean waters. As demonstrated in Figure 7, most of Connecticut is in one of the three phases of watershed activities. Although quantitative nitrogen reduction estimates are not available for these NPS/stormwater programs, it is expected that both direct and indirect reductions in nitrogen have occurred.

V Data Gaps and Recommended Improvements

The process of collecting and evaluating nonpoint source and stormwater control efforts in the Connecticut resulted in the findings that many programs work to address such efforts across the state. These programs are administered by CTDEEP, other state and federal agencies, and municipalities. Also, as a result of this evaluation, CTDEEP identified data gaps and recommendations that would strengthen efforts if they are addressed. Both data gaps and recommendations are listed below.

Data Gaps:

- Land cover change analyses do not account for the installation of BMPs that may have been implemented as a condition of building activities.
- Inconsistent data entry into GRTS among states and years, data difficult and timely to query.
- The scope of the level and impact for many of the management programs that are in place is unknown. For instance, only those pump out facilities operating under the CVA that receive grant funding are required to report the number of gallons pumped or prevented from entering LIS.
- No follow-up regarding the incorporation of LID requirements into town regulations. OLISP gets proposals but is not notified of which municipalities actually adopt them into regulations.
- Not all MS4 activities are reported. For instance, towns that conduct illicit discharge detection and elimination activities are not required to report their finding and subsequent solutions.
- Lack of follow-up with implementation activities in order to assess their effectiveness. This includes but is not limited to implementation grants and assistance to the agricultural community (i.e. activities conducted under NMPs have a time limited effectiveness.
- Reliance on self-reporting by CLEAR has resulted in under reporting.
- Limited tracking of sewer projects and septic system upgrades.

Recommendations:

- Since requiring reporting of every Best Management Practice would likely reduce the amount of resources available for implementation, indicators of nitrogen reductions should be selected for tracking purposes. It may be more beneficial under many circumstances and given limited resources for implementation activities to select certain indicators of nitrogen reduction, as opposed to trying to account for all activities. Required reporting of everything is certain to impede implementation efforts. Consider using indicators that are easily (or can be easily) tracked and more representative of nitrogen reductions on a larger scale for tracking purposes. Examples of these indicators include the number of towns requiring LID techniques and/or septic system pump-out and inspections; towns that consider LIS in their zoning and planning regulations or conservation and development

plans; coastal site plan reviews that incorporate OLISP's guidance (and other NPS/Stormwater controls). The effectiveness of implementation efforts (including those tracked and not tracked) can be inferred using in-stream monitoring data (pending the utility of the United States Geological Survey weighted regressions approach).

- Consider making current reductions in air nitrogen permanent. The ambient air nitrate reductions recently recorded are believed to be the result of regulations, economic decline, and the increase in natural gas availability. When economic output increases, we will likely experience an increase in atmospheric nitrogen since much of the reduction realized is not the result of regulatory controls.
- There is a need to improve and standardized MS4 reporting requirements, and provide for electronic submittal of data and information.

VI Summary and Conclusions

Since the LIS TMDL (nitrogen) baseline was established in 1990, CTDEEP developed a number of state programs both regulatory and non-regulatory designed to address pollution caused by nonpoint source and stormwater. Some of these programs directly target nitrogen as a primary pollutant, such as the industrial stormwater and MS4 permits; agricultural partnerships; CSO control projects, onsite wastewater permits, sanitary sewer extensions. Other programs, while not specifically targeting nitrogen, result in nitrogen reductions as an outcome of management efforts. Such programs include 319-nonpoint source (NPS) and other grant funded programs; coastal NPS; watershed management; low impact development; state commercial and construction stormwater permits; marine vessel pump-out requirements under the Clean Vessel Act; and a number of pollution prevention, technical assistance and education programs. While not all programs monitor and track nitrogen reductions quantitatively, real reductions in nitrogen have been demonstrated in stormwater sampling data contained within the industrial stormwater database (1995-2011). The greatest reductions in nitrate and total kjeldahl nitrogen (TKN) were observed in the 95th percentile data (i.e. the highest concentrations). Both nitrate and TKN have been reduced by 50% and 29%, respectively. Ambient air monitoring indicates a 40% (approximate) decrease in nitrite levels, with most of the decline occurring post-2000. This decrease in the atmospheric nitrogen concentration as well as an increase in the stormwater management permit requirements has largely contributed to the decrease seen in the industrial stormwater nitrogen data.

As presented in this report, increases in population and developed areas continue to occur within the state. However, new development and redevelopment, including that which occurs in important riparian and near shore areas, is now better regulated at both the state and local level minimizing nonpoint sources of nitrogen. CTDEEP provides all municipalities with training, technical assistance

and guidance, and education and outreach concerning NPS management including nitrogen. CTDEEP targets nonpoint source and stormwater management within the coastal boundary creating an added level of protection in the areas immediately adjacent to LIS. In addition, local projects within the coastal boundary are required to follow the coastal site planning process which includes review and oversight by CTDEEP's Office of Long Island Sound Programs. While overall Connecticut has experienced an increase in population and developed land cover, there has also been a corresponding enhancement in nonpoint source and stormwater management and related land use management programs.

This preliminary qualitative evaluation of nonpoint source and stormwater control efforts was completed with the goal of generally assessing the effectiveness of efforts toward meeting the LIS TMDL load allocations that were assigned to urban and agricultural NPS categories. Based on the degree of legislative efforts and new and enhanced regulatory and non regulatory programs that were initiated following the TMDL baseline (1990), Connecticut expects to be on target toward meeting the TMDL load allocations for nonpoint and stormwater sources. It is important to note that a preliminary finding of the nitrogen loading trends study conducted by the United States Geological Survey (USGS) indicates that nitrogen loading is some tributaries has increased in recent years (post-2000). However, this increase is thought to be the result of increased precipitation and in-stream flow. Because of this, CTDEEP supports the USGS proposed average regressions analysis in order to better understand the effect of increased precipitation on nitrogen loading and the outcome of greater NPS regulatory/control efforts.

Appendix A
Connecticut Department of Environmental Protection
Bureau of Water Management
Nonpoint Source Management Program

Appendix B
Connecticut Department of Energy and Environmental Protection
Nonpoint Source Management Program
2011 Annual Report

Appendix C
Connecticut Department of Energy and Environmental Protection
Nonpoint Source and Stormwater Nitrogen Control Efforts

Connecticut Inventory of stormwater/NPS control efforts relative to Nitrogen										
DRAFT_120312										
Control Efforts / Program	**Contact**	**Date of Impl.**	**Comments**	**Limitations**	**Data type**	**Submittal Format**	**Parameters**	**Sample Freq**	**Record Length**	**# Sites / Facilities**
Broad Statewide Controls										
CAFO/AFO - Comp Nutrient Mgt Plans	Joe Wetteman	Between 1990 & 2012 - 269 NMPs were approved. NRCS contracts with farmers for 3 - 5 years. Structural installations (manure storage, silage leachate collection) should last for a longer period.	It is expected that a permit will be required for CAFO's in the near future. Working with NRCS to acquire information regarding nitrogen reduction efforts.	No records prior to 1990. Number of farms implementing NMPs varies from year to year.	Text		acreage/nutrients, As of 2009, CT had 10 CAFO's and 35 AFO's.			
Clean Marina	MaryBeth Hart	2007	Program participation requires compliance with Industrial Stmwtr GP	Voluntary but marina's pledge each year to participate		Inventory of BMPs or demo projects				
Clean Vessel Act	Kate Brown	Stonington_8/22/03, Mystic/Groton_09/24/04, Groton/Guilford_05/12/06, Branfd/Greenwich_06/15/09	Gallons pumped can be used to estimate nitrogen load discharge prevented from entering LIS	Only grant funded pump-outs are required to report.	Pump-out reporting	Voluntary pump-out reporting required if state/federal funded	2010 = 619,735 Gallons 2011 = 517,952 Gallons			
Conversion of residential land from standard practices to organic lawn care	Kelly Streich	1999	NOFA program to convert residential and farm land to organic lawn care practices (203.888.5146).	Accounting of acres converted to organic lawn care practices not available.						
Change in Fertilizer Formulation	Clair Ryan, NEIWPCC	Currently negociating	Voluntary changes in the formulation by manufacturers.							
Outreach / Education	SeaGrant									
NEMO LID Atlas	Chet Arnold, UCONN		Maybe difficult to separate LID tecniques installed prior to TMDL baseline.	Internet explorer may be older than IE8. LID atlas not functioning correctly.						
NEMO Education/Information Programs	Chet Arnold, UCONN									
CGS Title 8 Chapter 124 8-2 - Zoning. (b)	MaryBeth Hart	PA91-170	State Reg that requires towns to consider LIS in C&D plans, as well as zoning regulations.	8-2(b) In any municipality that is contiguous to Long Island Sound, the regulations adopted under this section shall be made with reasonable consideration for restoration and protection of the ecosystem and habitat of Long Island Sound and shall be design						
CGS Title 8 Chapter 126, 8-23 - Preparation, amendment or adoption of plan of conservation and development. (e)(2)	MaryBeth Hart	PA91-398	State Reg that requires towns to consider LIS in C&D plans, as well as zoning regulations.	8-23(e)(2) For any municipality that is contiguous to Long Island Sound, such plan shall be (A) consistent with the municipal coastal program requirements of sections 22a-101 to 22a-104, inclusive, (B) made with reasonable consideration for restoration an						

Connecticut Inventory of stormwater/NPS control efforts relative to Nitrogen										
DRAFT_120312										
Control Efforts / Program	**Contact**	**Date of Impl.**	**Comments**	**Limitations**	**Data type**	**Submittal Format**	**Parameters**	**Sample Freq**	**Record Length**	**# Sites / Facilities**
Programmatic Controls										
Industrial Stormwater GP	Carol Papp	1992	Representative sample where Qs to surface wtr; Can do statistics, trends; New permit issued in Oct 2011 - by Sector, parameters & freq may change; not yet in system	Don't necessarily know BMPs or changes in sampling locations (might find in old rpts)	Excel	Registration, Stormwater mgt plan, Stormwater Monitoring Report forms	O&G: pH; COD; TSS; TP; TKN; NO3; Fecal Col (stopped in 2002); Total Cu; Total Zn; Total Pb; 24 & 48 hr LC50; 24 & 48 hr ATU; hardness; 24 & 48 hr NOAEL, visual	annual	1995	1400 - 1700
Commercial Stormwater GP		1992	Stormwater mgt plans with good housekeeping practices, retention requirements for discharges located <100' from tidal wetlands			Registration	No monitoring required, visual inspection			
MS4 Permits	Carol Papp	2004	sample 6 outfalls: 2 residential; 2 indust; 2 comm sites - could find bmps etc in report	sampling pt may vary, no info on facility size, option to conduct instream sampling	Excel	Registration, Stormwater mgt plan, Annual reports	O&G; pH; E. coli; harness; conductivity; TP; COD, TSS, Turbidity; NO3 + NO2; TKN; NH3	annual	2004	114
Construction GP		1995	During & post construction sediment controls; new permit will have turbidity monitoring & retention requirements, Does not count towards baseline reductions			Registration, Stormwater mgt plan	No monitoring required			
Specific Targeted Projects/Monitoring										
319 NPS Implementation Grants	MaryAnn Nusom-Haverstock		Query GRTS database to obtain load reduction information on implementation grants.	Load estimates are provided through modeling	GRTS		Nitrogen load reduced			
CTDEEP website of 319 grant funded projects			Connecticut NPS Pollution Projects website includes a location map of relevant 319 grant funded projects. https://www.depdata.ct.gov/maps/nps/npsmaps.htm							
Non-319 funding Watershed Implementation Activities	CTDEEP website/ watershed group/ Kate Brown/ Mark Tedesco									
USGS N Trend Monitoring	John Mullaney		Tributary nitrogen loading trend analysis, 1990-2000. Loading estimates will be provided for ungaged watersheds.							

Connecticut Inventory of stormwater/NPS control efforts relative to Nitrogen										
DRAFT_120312										
Control Efforts / Program	**Contact**	**Date of Impl.**	**Comments**	**Limitations**	**Data type**	**Submittal Format**	**Parameters**	**Sample Freq**	**Record Length**	**# Sites / Facilities**
Programmatic Controls - Continued										
N Removal BMP Efficiency	Shimon Ainsfield		Wetland/wet pond efficiency study with inventory of 60 installations; data provided for 8.							
Pine Grove Sewer connection http://ct.water.usgs.gov/projects/PineGrove/pinegroveTT.htm	John Mullaney	2005 - 2010 - Data indicates reductions in some of the wells. Specifically, the shallow (30') and mid-depth wells (45'). The deeper wells (65') did not appear to impacted by nitrogen loading.	Work began in 2005 and was completed in 2010. Data was collected for pre and post connection conditions.				172 residential properties on 35 acres of land along the Niantic River.			
Advanced Wastewater Treat Sys	Dennis Greci	As of the end of 2011, twenty-five properties have been upgraded. The next contract is out to bid. A total of 360 properties are to be completed by the end of 2013. Funding is provided thru the Clean Water Fund.	On site systems in Old Saybrook upgraded to advanced treatment due to improperly functioning standard systems				load reduction?			
Upgrades from Septic to Sewer	Dennis Greci	1990 vs. 2010 census data	1990 = 1.23 million households & 385,309 septic systems (31.3%); 2010 = 1.37 million households & 570,000 septic systems (41.6%).	Although the amount of households using septic systems increased, CT DEEP and local municipalities have made advances in sewering areas known to have poorly drained soils or high groundwater tables making the property unsuitable for septic sytem use. Tho						
Combined Sewer Overflows	Ivonne Hall	Prior to 1990, CT had 13 CSO communities (257 total). As of 2011, 6 CSO communities remained (115 individual including 6 plant bypasses).	Number of CSO's prior to 1990 and currently existing, Number of CSO's with long term control plans, Implementation status of plans.							
Watershed Mgt Plans	Kelly Streich	First plan dated 1991	DEEP watershed management plans website. http://www.ct.gov/dep/cwp/view.asp?A=2719&Q=379296							
Watershed Mgt Plans Implementation Map	Mark Tedesco	2003	The LISS tracks the implementation status of watershed plans with the goal of having 50% of the CT and NY portion of the watershed developing or implementing watershed restoration plans. http://longislandsoundstudy.net/2010/07/watershed-management/?doing							

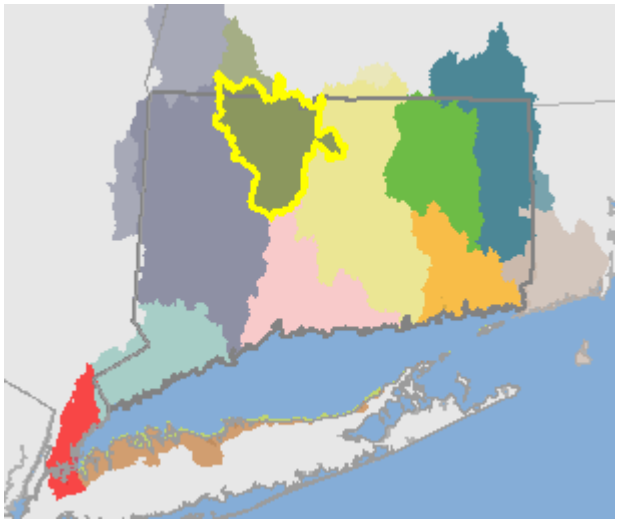
Connecticut Inventory of stormwater/NPS control efforts relative to Nitrogen										
DRAFT_120312										
Control Efforts / Program	**Contact**	**Date of Impl.**	**Comments**	**Limitations**	**Data type**	**Submittal Format**	**Parameters**	**Sample Freq**	**Record Length**	**# Sites / Facilities**
Programmatic Controls - Continued										
NEMO LID Atlas	Chet Arnold, UCONN		A total of 80 LID sites are included on the atlas. However, population of the atlas relies on public reporting.	Have to assume that the LID techniques were installed after 1991 (when NEMO was created).						
CLEAR/NEMO Education/Information Programs	Chet Arnold, UCONN	1991	Provides information, education and assistance to land use decision makers, community organizations, and citizens about the relationship between land use and natural resources, particularly water quality. Both CLEAR and NEMO promote responsible land use	The programs focus is on stormwater controls. Unable to determine a level of effectiveness in controlling nitrogen.						
UCONN CLEAR Land Cover Change	Chet Arnold, UCONN	1985	Land cover change since 1985. 2010 data will be available shortly. Increase in turf is key.							
Adopted LID regulations	Chet Arnold, UCONN / Marybeth Hart		Nine towns have adopted LID requirements into their zoning and/or sub-division regulations.	Updated thru 2008, It is expected that additional towns have also adopted LID requirements.						
Miscellaneous										
Dog Waste Ordinances										
Septic System Pump out Reqs										
Cow/Chicken Map	Chris Sullivan	2012								
P-2	Judy Prill		An outreach/education program on DEEP's webpage. Includes a large variety of pollution prevention techniques. P2 produced an organic land care video for municipalities.	Not targeted to Nitrogen						

Connecticut Inventory of stormwater/NPS control efforts relative to Nitrogen										
DRAFT_120312										
Control Efforts / Program	**Contact**	**Date of Impl.**	**Comments**	**Limitations**	**Data type**	**Submittal Format**	**Parameters**	**Sample Freq**	**Record Length**	**# Sites / Facilities**
Miscellaneous - Continued										
Golf Course Mgt	Corinne Fitting / Doug Hoskins	2006	Golf courses with permitted diversions must comply with the DEEP's manual "Best Management Practices for Golf Course Water Use", 2006. Such BMPs address surface & groundwater quality, wetlands protections, and stormwater mgt.							
Fairfield, swirl concentrators	Kelly Streich	Initiated ~ 1999, installations are ongoing	See document BMP Efforts Fairfield-CT_020912	No data available. Units installed to collect sediment.						
Norwalk catch basin inserts	Chris Malik		See Document BMP Efforts Nowalk-CT_030112	No good monitoring data available. Two studies indicated that units catch silt, debris, and trash. One study indicated that another mfg filter tends to quickly clog.						
CT Guidelines for soil erosion and sediment control, with LID appendix (2011), http://www.ct.gov/dep/lib/dep/water/nps/swgp/lid_soilerosionfinal.pdf		1988 - renewed in 2002	intended to provide information to government agencies and the public on soil erosion and sediment control. These guidelines fulfill the requirements of Connecticut's Soil Erosion and Sediment Control Act (§§ 22a-325 through 22a-329 of the Connecticut Gen							
Water Quality Manual, with LID appendix (2011), http://www.ct.gov/dep/lib/dep/water/nps/swgp/lid_stormwaterfinal.pdf		2004	guidance on the measures necessary to protect the waters of the State of Connecticut from the adverse impacts of post-construction stormwater runoff. This manual focuses on site planning, source control, and stormwater treatment practices and is intended							

Appendix D
Land Cover Data for HUC 8 Basins
Impervious Cover, Land Change and Riparian Zone Land Change Analyses
Source: UCONN CLEAR-Long Island Sound Watershed's Changing Landscape Project

FARMINGTON BASIN

The total area of the Farmington Basin is approximately 607 square miles (388,321 acres). The land cover data includes 81% of that area, or approximately 495 square miles (316,734 acres).



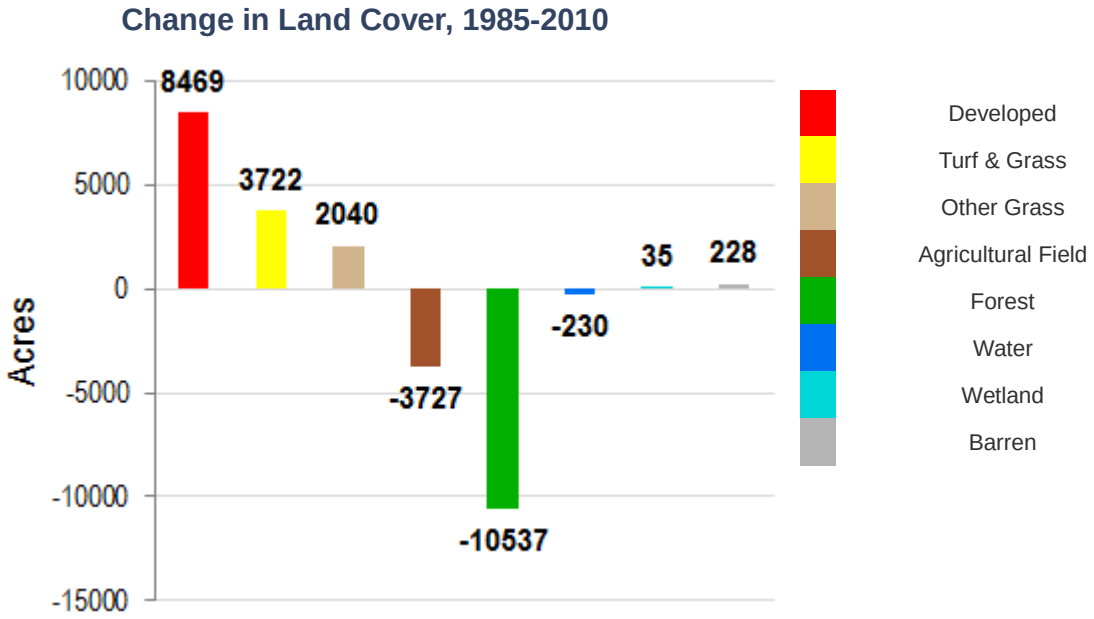
Farmington Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
15276	2.3%	16169	2.4%	16469	2.4%	16934	2.5%	17283	2.6%	17381	2.6%	2105	0.3%

FARMINGTON BASIN

Basin Land Cover – 1985, 2010, and Change.

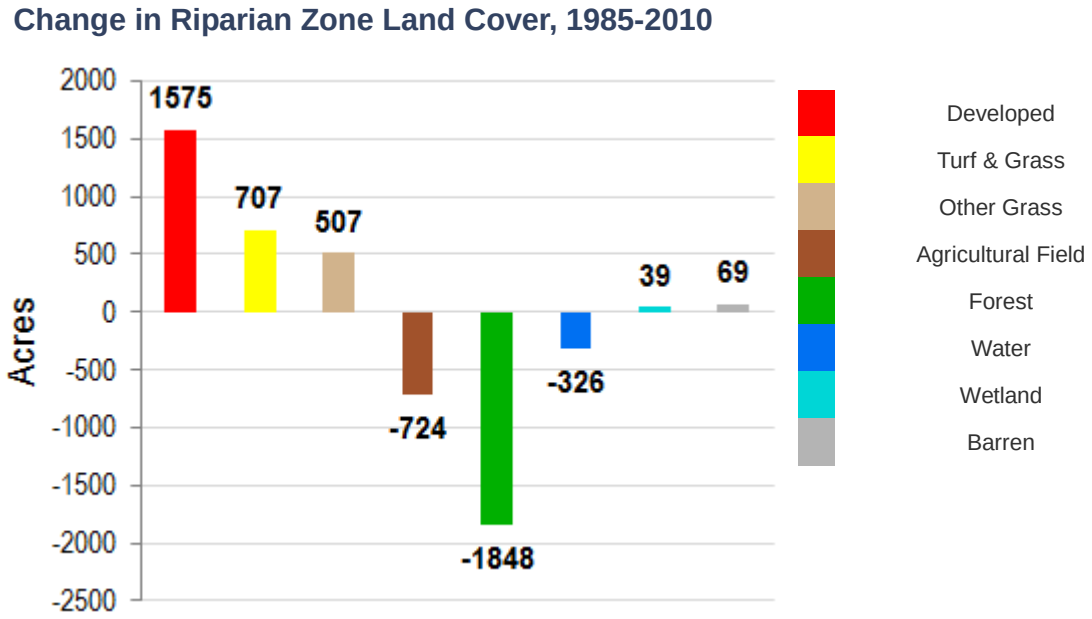
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	35822	11.7%	44291	14.5%	8469	2.8%
Turf & Grass	14189	4.6%	17911	5.9%	3722	1.2%
Other Grass	3607	1.2%	5647	1.8%	2040	0.7%
Ag. Field	19743	6.5%	16017	5.2%	-3727	-1.2%
Deciduous Forest	124399	40.7%	116941	38.3%	-7458	-2.4%
Coniferous Forest	83283	27.2%	81092	26.5%	-2191	-0.7%
Water	10457	3.4%	10227	3.3%	-230	-0.1%
Non-forested Wetlands	1218	0.4%	1253	0.4%	35	0.0%
Forested Wetlands	10120	3.3%	9258	3.0%	-862	-0.3%
Tidal Wetlands	0	0.0%	0	0.0%	0	0.0%
Barren	2001	0.7%	2230	0.7%	228	0.1%
Utility ROW (Forest)	864	0.3%	838	0.3%	-26	0.0%



FARMINGTON BASIN

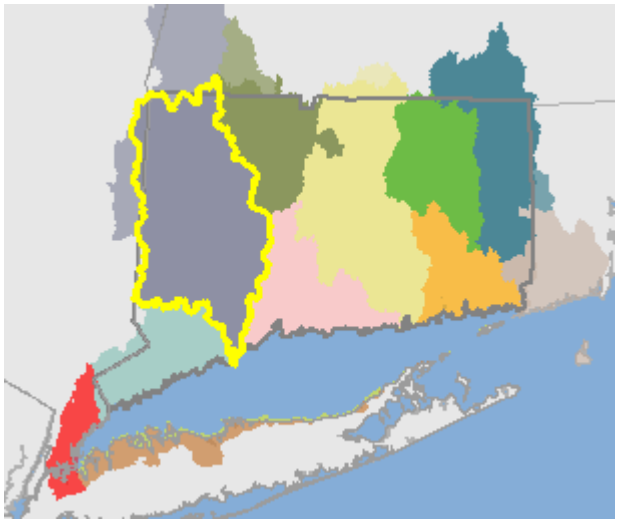
Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	9194	12.6%	10770	14.7%	1575	2.2%
Turf & Grass	3216	4.4%	3924	5.4%	707	1.0%
Other Grass	845	1.2%	1353	1.9%	507	0.7%
Ag. Field	4212	5.8%	3489	4.8%	-724	-1.0%
Deciduous Forest	26977	36.9%	25911	35.5%	-1065	-1.5%
Coniferous Forest	19597	26.8%	19292	26.4%	-305	-0.4%
Water	2246	3.1%	1920	2.6%	-326	-0.4%
Non-forested Wetlands	702	1.0%	741	1.0%	39	0.1%
Forested Wetlands	5393	7.4%	4917	6.7%	-476	-0.7%
Tidal Wetlands	0	0.0%	0	0.0%	0	0.0%
Barren	505	0.7%	575	0.8%	69	0.1%
Utility ROW (Forest)	153	0.2%	152	0.2%	-2	0.0%



HOUSATONIC BASIN

The total area of the Housatonic Basin is approximately 1950 square miles (1,248,001 acres). The land cover data includes 66% of that area, or approximately 1288 square miles (824,513 acres).

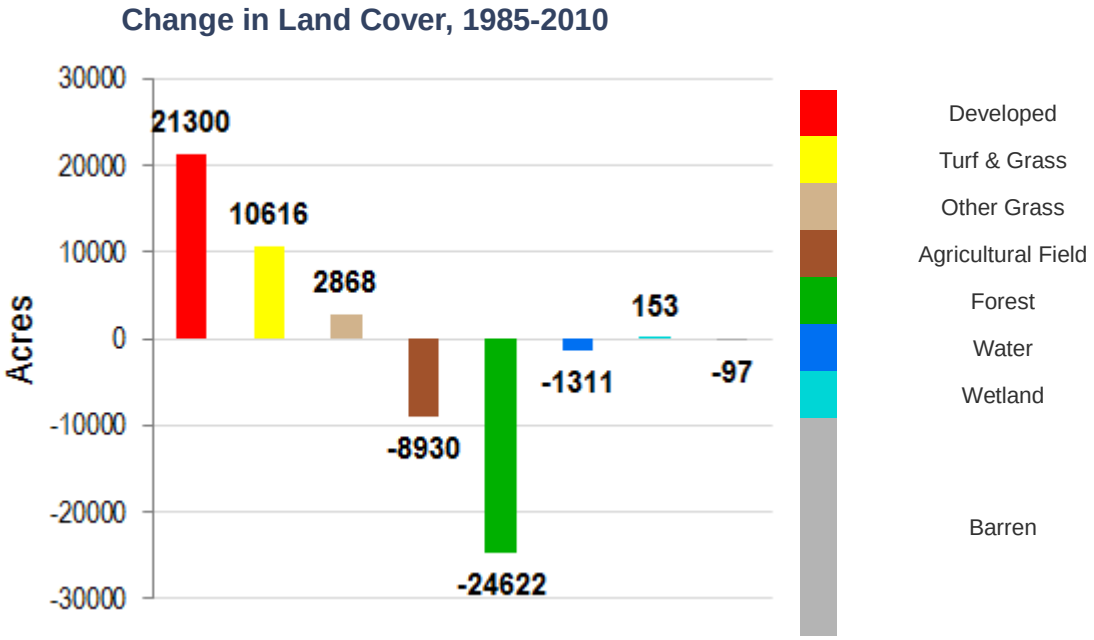


Housatonic Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
44256	6.6%	46456	6.9%	47206	7.0%	48427	7.2%	49320	7.3%	49661	7.4%	5405	0.8%

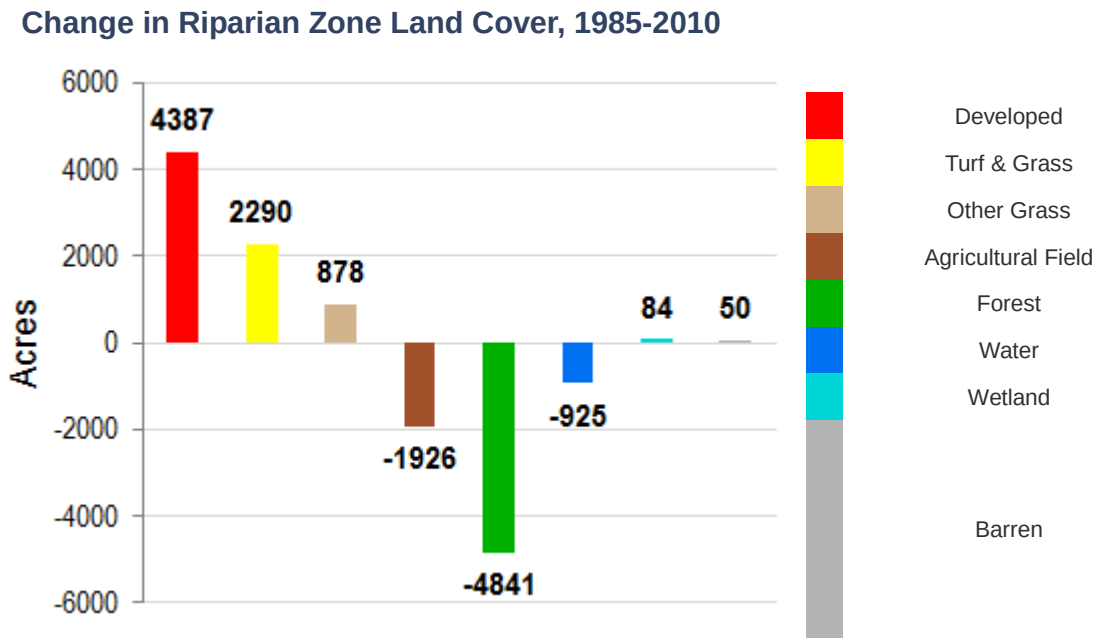
Basin Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	102676	12.8%	123977	15.4%	21300	2.6%
Turf & Grass	39815	5.0%	50431	6.3%	10616	1.3%
Other Grass	8372	1.0%	11240	1.4%	2868	0.4%
Ag. Field	83411	10.4%	74481	9.3%	-8930	-1.1%
Deciduous Forest	422740	52.6%	401057	49.9%	-21683	-2.7%
Coniferous Forest	84400	10.5%	82621	10.3%	-1779	-0.2%
Water	29921	3.7%	28609	3.6%	-1311	-0.2%
Non-forested Wetlands	2793	0.3%	2970	0.4%	178	0.0%
Forested Wetlands	22607	2.8%	21454	2.7%	-1153	-0.1%
Tidal Wetlands	407	0.1%	383	0.0%	-25	0.0%
Barren	4533	0.6%	4436	0.6%	-97	0.0%
Utility ROW (Forest)	2383	0.3%	2375	0.3%	-8	0.0%



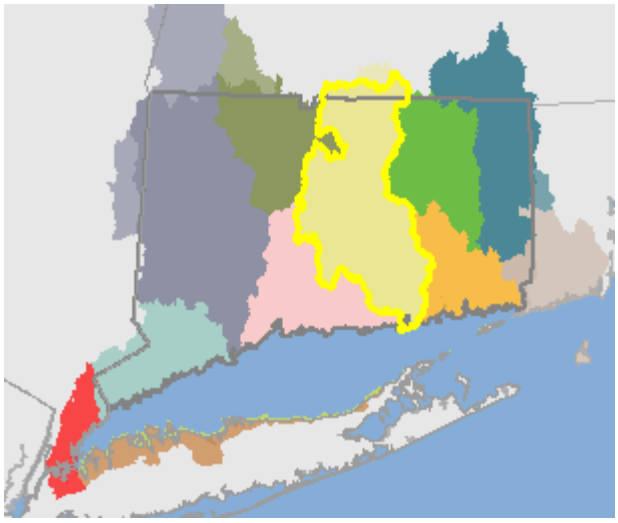
Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	28284	13.8%	32671	15.9%	4387	2.1%
Turf & Grass	9056	4.4%	11346	5.5%	2290	1.1%
Other Grass	2326	1.1%	3204	1.6%	878	0.4%
Ag. Field	18341	8.9%	16416	8.0%	-1926	-0.9%
Deciduous Forest	102102	49.8%	98220	47.9%	-3882	-1.9%
Coniferous Forest	23760	11.6%	23397	11.4%	-363	-0.2%
Water	6405	3.1%	5480	2.7%	-925	-0.5%
Non-forested Wetlands	1715	0.8%	1807	0.9%	92	0.0%
Forested Wetlands	11353	5.5%	10757	5.2%	-595	-0.3%
Tidal Wetlands	51	0.0%	43	0.0%	-8	0.0%
Barren	1208	0.6%	1259	0.6%	50	0.0%
Utility ROW (Forest)	596	0.3%	596	0.3%	0	0.0



LOWER CONNECTICUT BASIN

The total area of the Lower Connecticut River Basin is approximately 1050 square miles (672,595 acres).



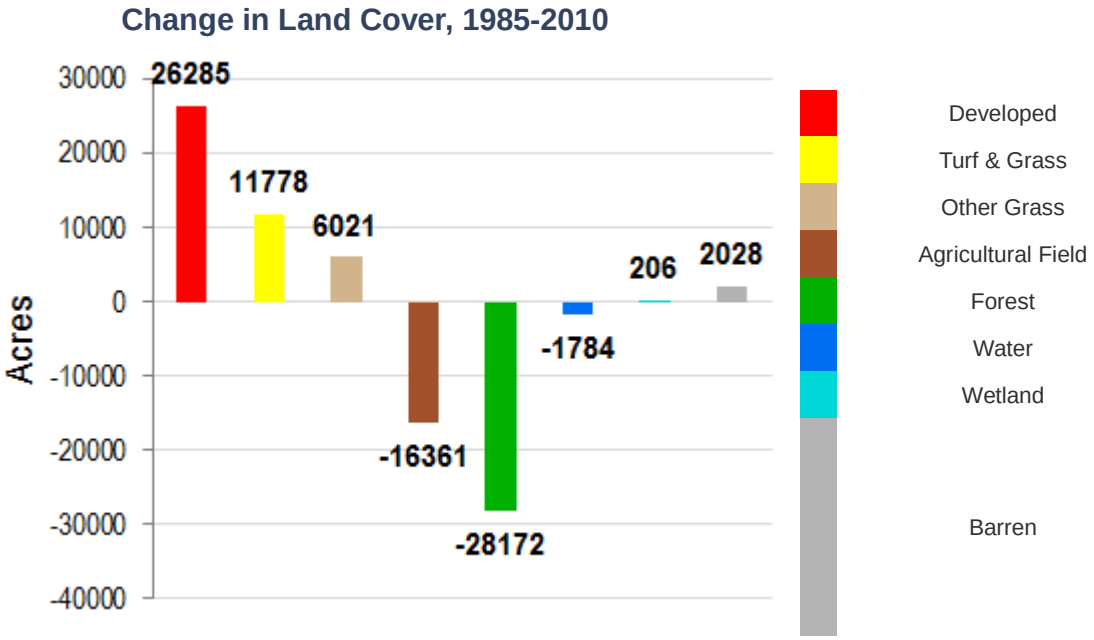
Lower Connecticut River Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
48488	7.2%	51131	7.6%	52175	7.8%	53913	8.0%	54825	8.2%	55244	8.2%	6756	1.0%

LOWER CONNECTICUT BASIN

Basin Land Cover – 1985, 2010, and Change.

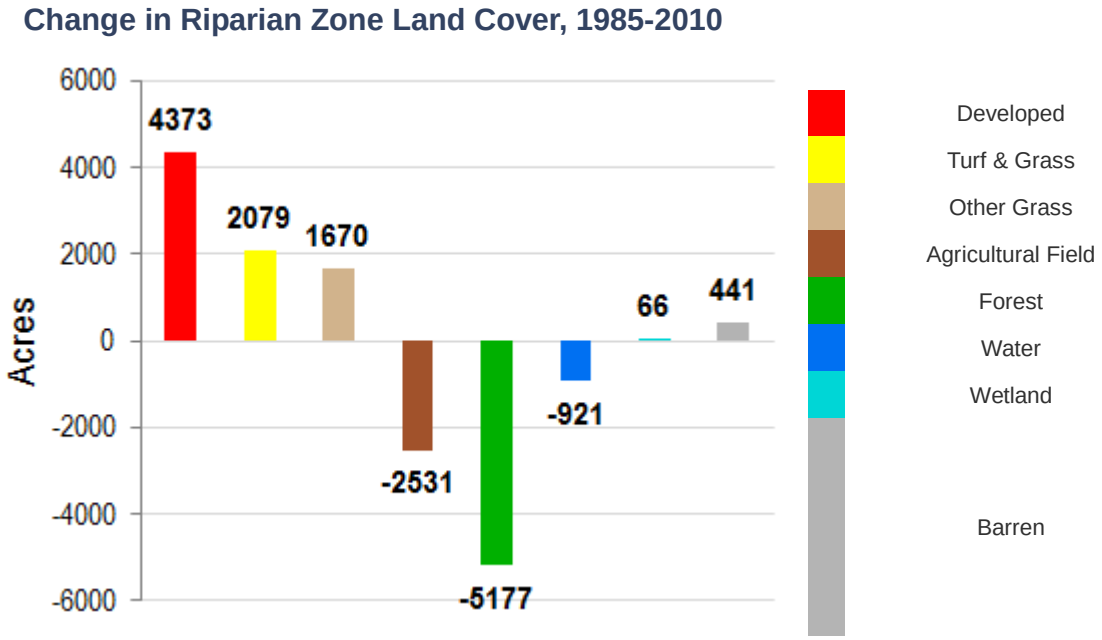
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	119020	18.0%	145304	22.0%	26285	4.0%
Turf & Grass	48487	7.3%	60266	9.1%	11778	1.8%
Other Grass	12737	1.9%	18758	2.8%	6021	0.9%
Ag. Field	74355	11.3%	57994	8.8%	-16361	-2.5%
Deciduous Forest	307300	46.5%	282286	42.7%	-25014	-3.8%
Coniferous Forest	35439	5.4%	33516	5.1%	-1923	-0.3%
Water	26965	4.1%	25181	3.8%	-1784	-0.3%
Non-forested Wetlands	2175	0.3%	2165	0.3%	-10	0.0%
Forested Wetlands	23146	3.5%	21983	3.3%	-1163	-0.2%
Tidal Wetlands	3901	0.6%	4118	0.6%	216	0.0%
Barren	3971	0.6%	5999	0.9%	2028	0.3%
Utility ROW (Forest)	3224	0.5%	3152	0.5%	-72	0.0%



LOWER CONNECTICUT BASIN

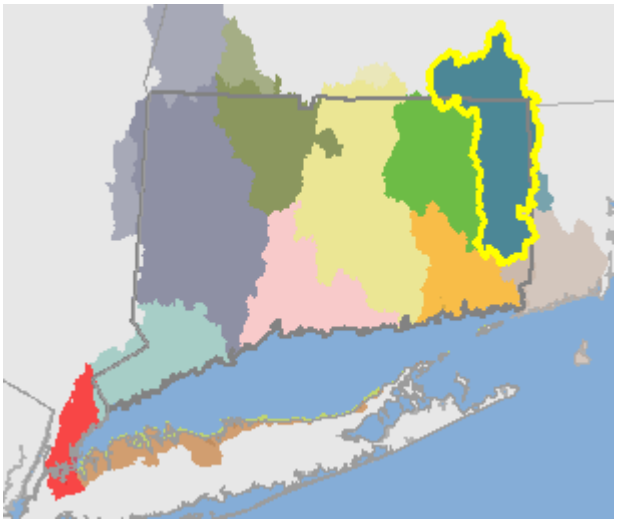
Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	23064	14.8%	27437	17.6%	4373	2.8%
Turf & Grass	9100	5.8%	11180	7.2%	2079	1.3%
Other Grass	2647	1.7%	4317	2.8%	1670	1.1%
Ag. Field	14498	9.3%	11967	7.7%	-2531	-1.6%
Deciduous Forest	76421	49.0%	72234	46.3%	-4187	-2.7%
Coniferous Forest	10745	6.9%	10369	6.6%	-376	-0.2%
Water	4919	3.2%	3998	2.6%	-921	-0.6%
Non-forested Wetlands	943	0.6%	943	0.6%	0	0.0%
Forested Wetlands	11419	7.3%	10819	6.9%	-600	-0.4%
Tidal Wetlands	650	0.4%	716	0.5%	66	0.0%
Barren	856	0.5%	1297	0.8%	441	0.3%
Utility ROW (Forest)	747	0.5%	732	0.5%	-14	0.0%



QUINEBAUG BASIN

The total area of the Quinebaug River Basin is approximately 704 square miles (450,397 acres).



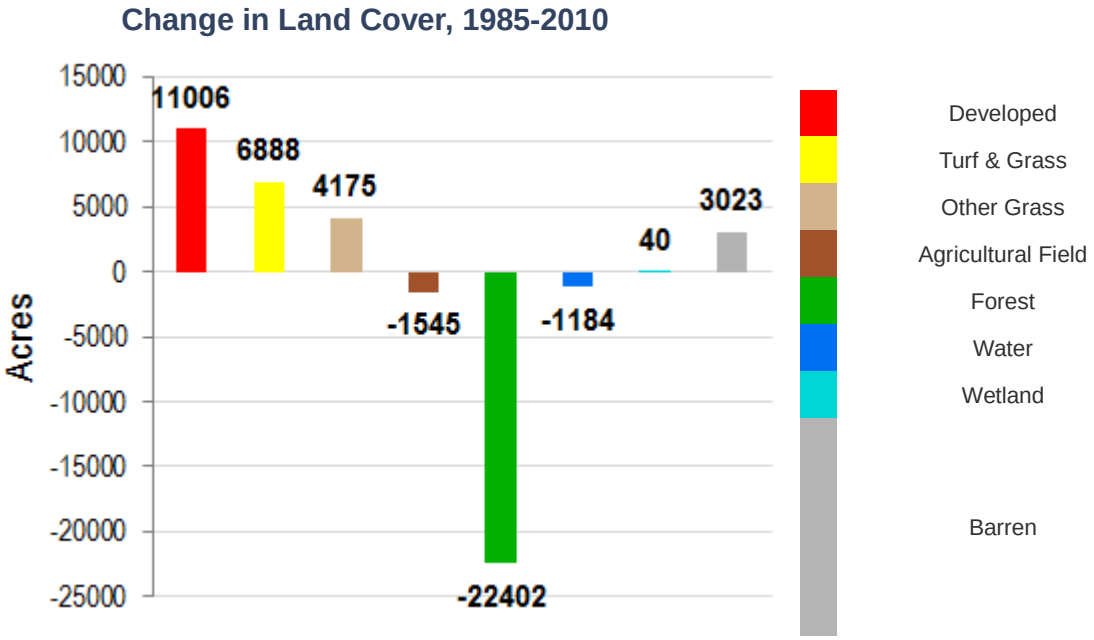
Quinebaug River Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
16976	2.5%	18129	2.7%	18735	2.8%	19492	2.9%	19871	3.0%	20008	3.0%	3032	0.5%

QUINEBAUG BASIN

Basin Land Cover – 1985, 2010, and Change.

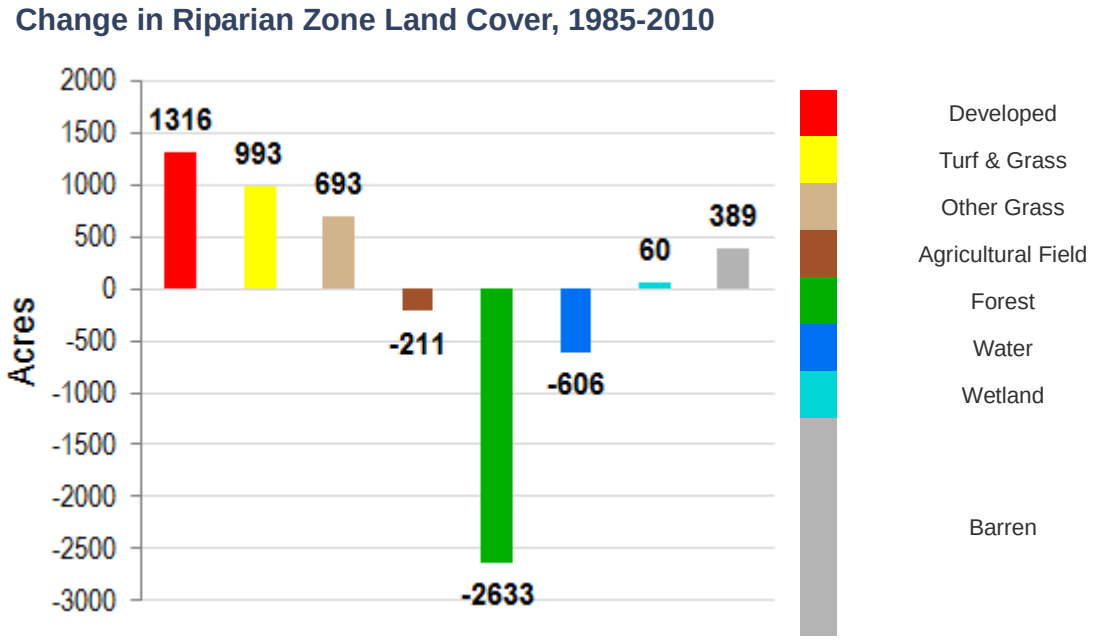
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	40273	8.9%	51279	11.4%	11006	2.4%
Turf & Grass	12538	2.8%	19426	4.3%	6888	1.5%
Other Grass	3975	0.9%	8149	1.8%	4175	0.9%
Ag. Field	41936	9.3%	40390	9.0%	-1545	-0.3%
Deciduous Forest	236565	52.5%	218564	48.5%	-18001	-4.0%
Coniferous Forest	63588	14.1%	60397	13.4%	-3191	-0.7%
Water	18175	4.0%	16991	3.8%	-1184	-0.3%
Non-forested Wetlands	4149	0.9%	4189	0.9%	40	0.0%
Forested Wetlands	25553	5.7%	24427	5.4%	-1126	-0.3%
Tidal Wetlands	0	0.0%	0	0.0%	0	0.0%
Barren	1870	0.4%	4893	1.1%	3023	0.7%
Utility ROW (Forest)	1619	0.4%	1535	0.3%	-84	0.0%



QUINEBAUG BASIN

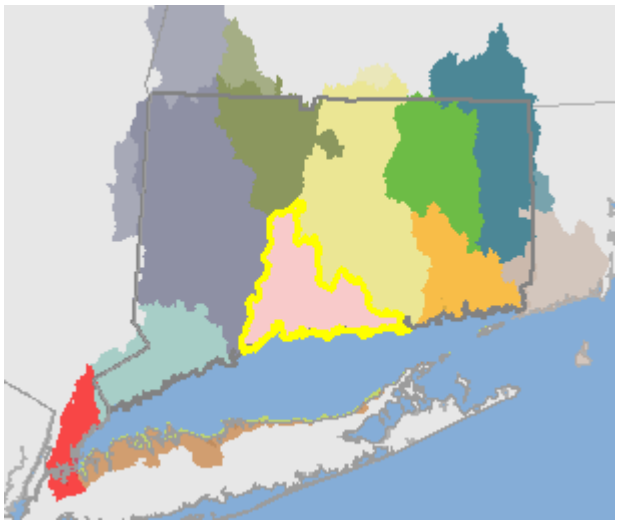
Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	6022	8.0%	7338	9.8%	1316	1.8%
Turf & Grass	2068	2.8%	3061	4.1%	993	1.3%
Other Grass	814	1.1%	1507	2.0%	693	0.9%
Ag. Field	7097	9.4%	6886	9.2%	-211	-0.3%
Deciduous Forest	36590	48.7%	34574	46.0%	-2016	-2.7%
Coniferous Forest	9365	12.5%	9042	12.0%	-324	-0.4%
Water	3069	4.1%	2463	3.3%	-606	-0.8%
Non-forested Wetlands	1389	1.8%	1448	1.9%	60	0.1%
Forested Wetlands	8279	11.0%	7997	10.6%	-282	-0.4%
Tidal Wetlands	0	0.0%	0	0.0%	0	0.0%
Barren	197	0.3%	586	0.8%	389	0.5%
Utility ROW (Forest)	212	0.3%	201	0.3%	-11	0.0%



QUINNIPIAC BASIN

The total area of the Quinnipiac River Basin is approximately 512 square miles (327,897 acres).



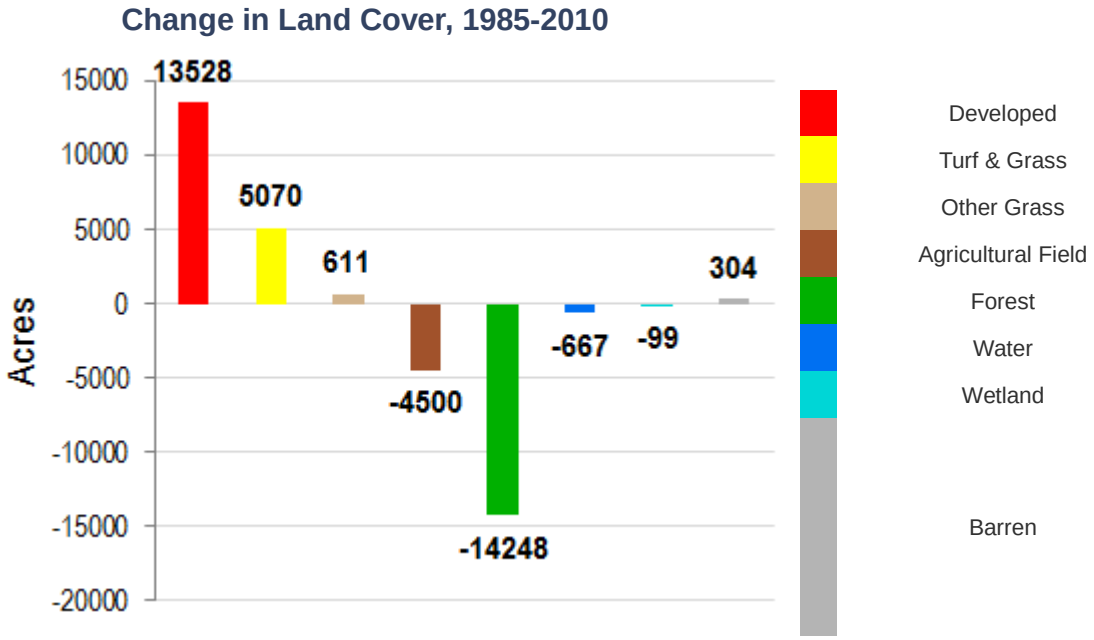
Quinnipiac River Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
33127	4.9%	34514	5.1%	35103	5.2%	35925	5.3%	36375	5.4%	36567	5.4%	3440	0.5%

QUINNIPIAC BASIN

Basin Land Cover – 1985, 2010, and Change.

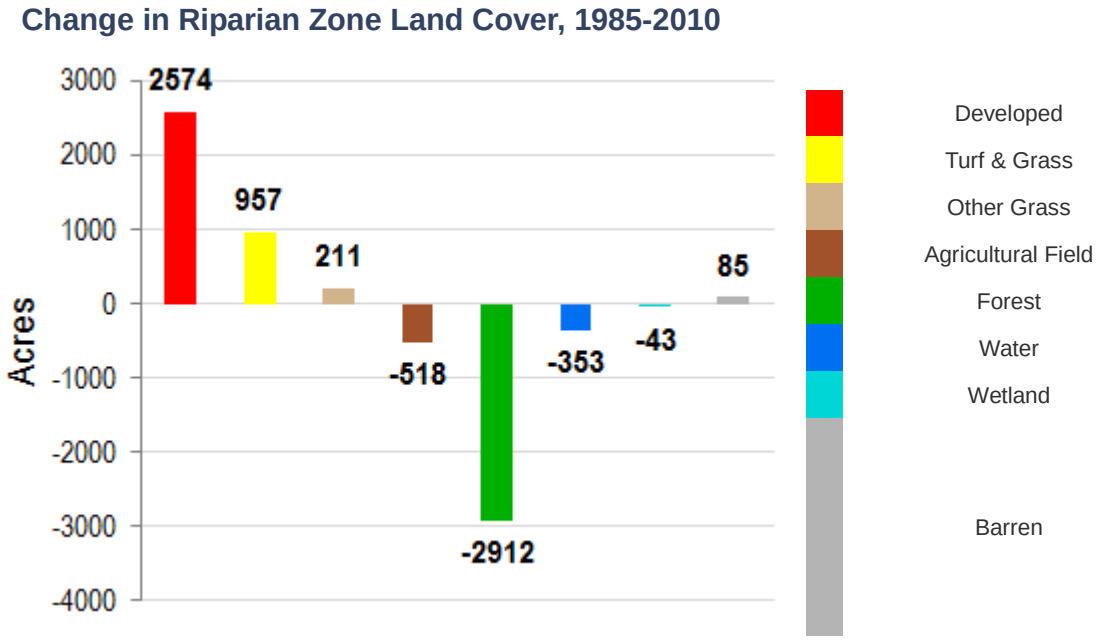
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	84353	25.7%	97881	29.9%	13528	4.1%
Turf & Grass	30521	9.3%	35591	10.9%	5070	1.5%
Other Grass	5766	1.8%	6377	1.9%	611	0.2%
Ag. Field	16512	5.0%	12012	3.7%	-4500	-1.4%
Deciduous Forest	146625	44.7%	133851	40.8%	-12774	-3.9%
Coniferous Forest	9543	2.9%	9078	2.8%	-464	-0.1%
Water	8367	2.6%	7701	2.3%	-667	-0.2%
Non-forested Wetlands	1054	0.3%	1111	0.3%	57	0.0%
Forested Wetlands	12718	3.9%	11766	3.6%	-952	-0.3%
Tidal Wetlands	7107	2.2%	6952	2.1%	-156	0.0%
Barren	4110	1.3%	4414	1.3%	304	0.1%
Utility ROW (Forest)	1221	0.4%	1163	0.4%	-58	0.0%



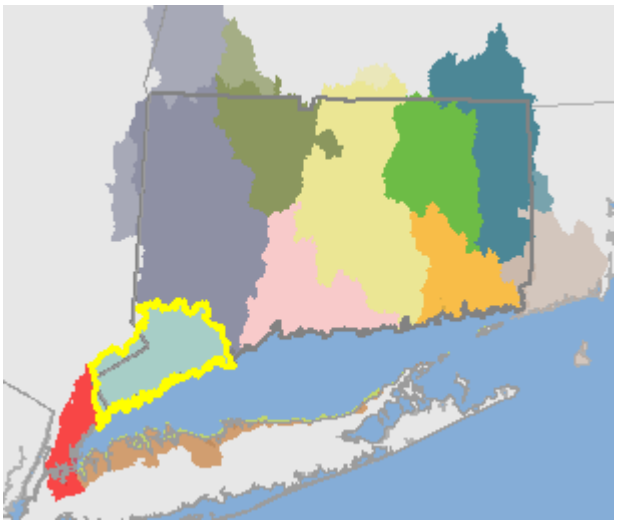
QUINNIPIAC BASIN

Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	17254	20.9%	19828	24.1%	2574	3.1%
Turf & Grass	5925	7.2%	6882	8.4%	957	1.2%
Other Grass	1315	1.6%	1525	1.9%	211	0.3%
Ag. Field	3212	3.9%	2694	3.3%	-518	-0.6%
Deciduous Forest	40097	48.7%	37727	45.8%	-2371	-2.9%
Coniferous Forest	3162	3.8%	3048	3.7%	-115	-0.1%
Water	1839	2.2%	1486	1.8%	-353	-0.4%
Non-forested Wetlands	510	0.6%	519	0.6%	9	0.0%
Forested Wetlands	6344	7.7%	5925	7.2%	-419	-0.5%
Tidal Wetlands	1598	1.9%	1546	1.9%	-52	-0.1%
Barren	801	1.0%	886	1.1%	85	0.1%
Utility ROW (Forest)	340	0.4%	332	0.4%	-8	0.0%



SAUGATUCK BASIN



The total area of the Saugatuck River Basin is approximately 450 square miles (287,614 acres).

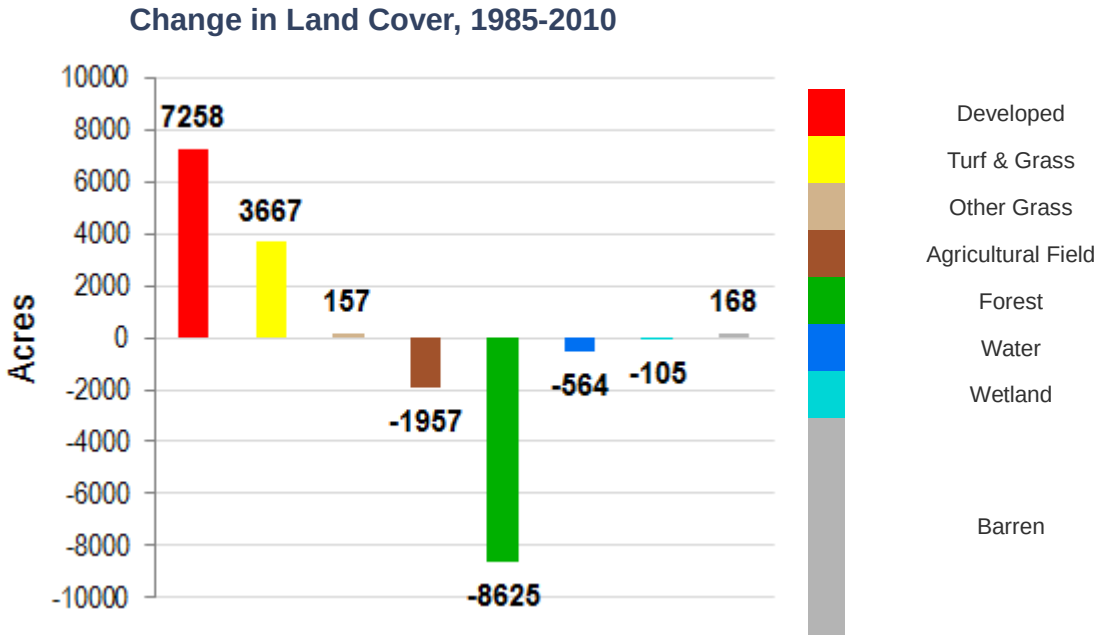
Saugatuck River Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
34345	5.1%	35026	5.2%	35361	5.3%	35767	5.3%	36079	5.4%	36391	5.4%	2046	0.3%

SAUGATUCK BASIN

Basin Land Cover – 1985, 2010, and Change.

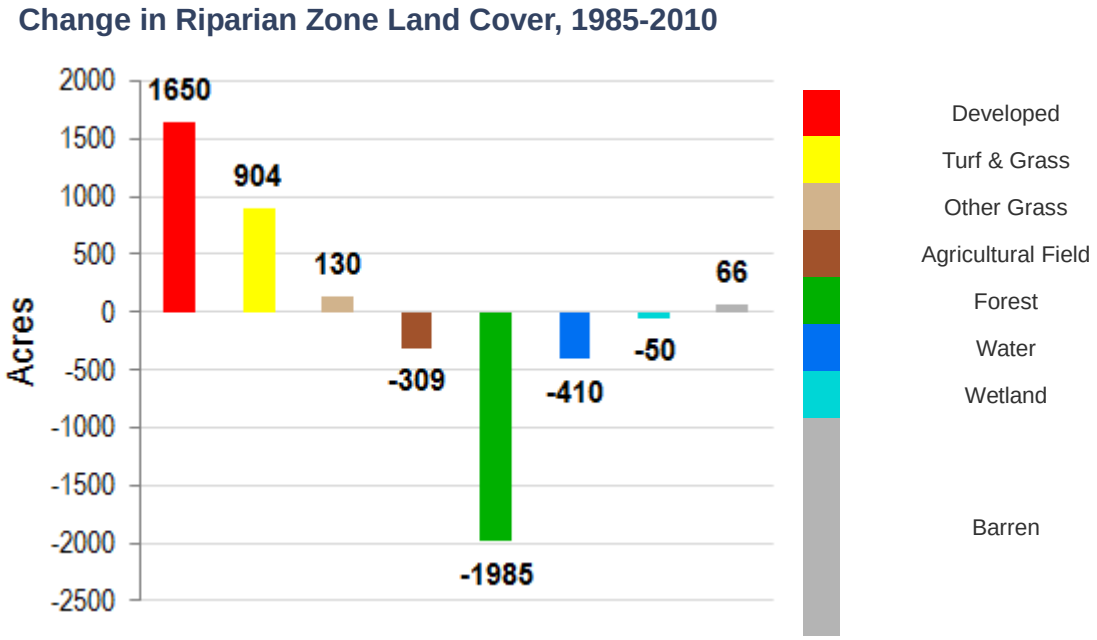
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	87821	30.5%	95079	33.1%	7258	2.5%
Turf & Grass	42452	14.8%	46119	16.0%	3667	1.3%
Other Grass	3276	1.1%	3433	1.2%	157	0.1%
Ag. Field	5057	1.8%	3099	1.1%	-1957	-0.7%
Deciduous Forest	118041	41.0%	110834	38.5%	-7206	-2.5%
Coniferous Forest	11361	4.0%	10525	3.7%	-836	-0.3%
Water	8531	3.0%	7967	2.8%	-564	-0.2%
Non-forested Wetlands	337	0.1%	333	0.1%	-4	0.0%
Forested Wetlands	7492	2.6%	6900	2.4%	-592	-0.2%
Tidal Wetlands	1329	0.5%	1229	0.4%	-100	0.0%
Barren	1591	0.6%	1759	0.6%	168	0.1%
Utility ROW (Forest)	327	0.1%	336	0.1%	10	0.0%



SAUGATUCK BASIN

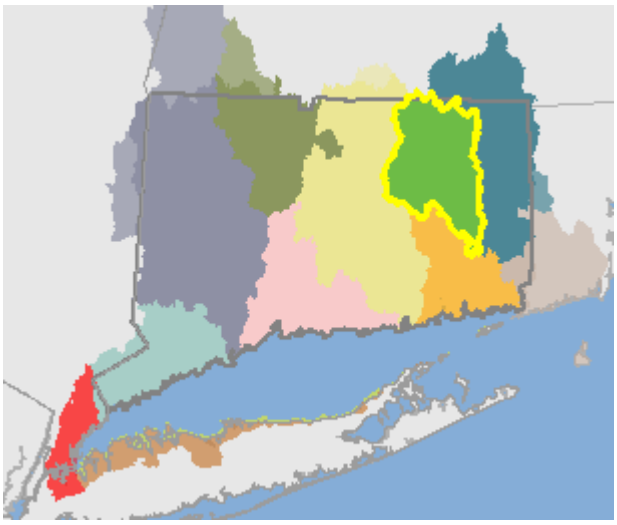
Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	21429	25.4%	23079	27.4%	1650	2.0%
Turf & Grass	9432	11.2%	10336	12.3%	904	1.1%
Other Grass	783	0.9%	913	1.1%	130	0.2%
Ag. Field	816	1.0%	506	0.6%	-309	-0.4%
Deciduous Forest	39987	47.5%	38533	45.8%	-1454	-1.7%
Coniferous Forest	4167	4.9%	3995	4.7%	-172	-0.2%
Water	2165	2.6%	1755	2.1%	-410	-0.5%
Non-forested Wetlands	180	0.2%	179	0.2%	0	0.0%
Forested Wetlands	4387	5.2%	4030	4.8%	-357	-0.4%
Tidal Wetlands	352	0.4%	302	0.4%	-50	-0.1%
Barren	403	0.5%	469	0.6%	66	0.1%
Utility ROW (Forest)	113	0.1%	110	0.1%	-3	0.0%



SHETUCKET BASIN

The total area of the Shetucket River Basin is approximately 526 square miles (336,797 acres).



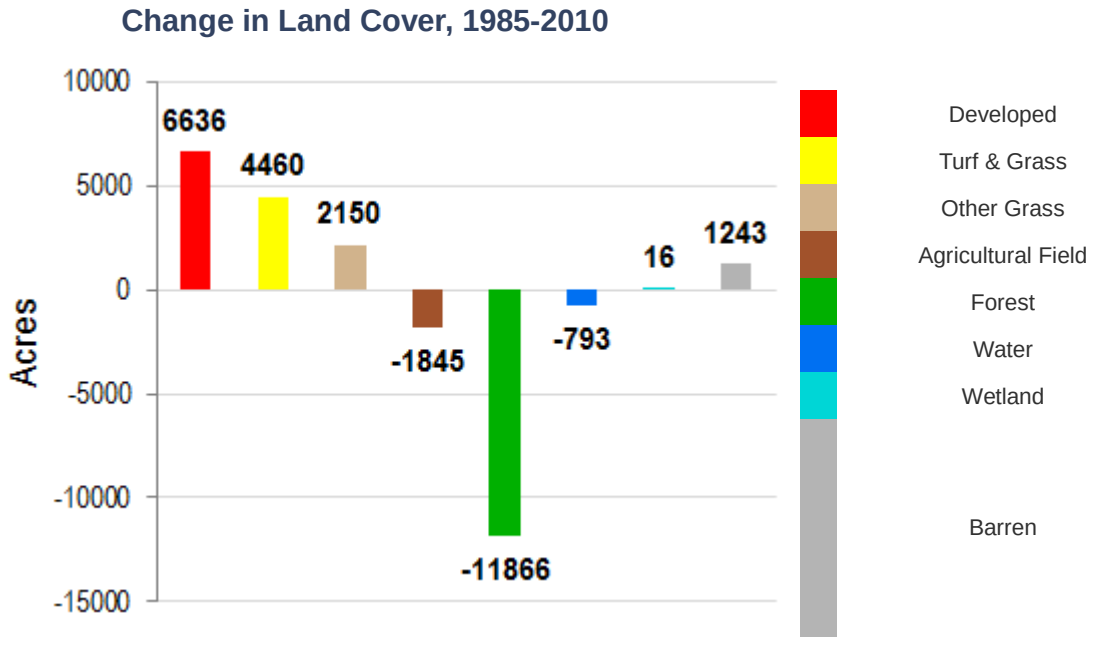
Shetucket River Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
12596	1.9%	13216	2.0%	13616	2.0%	14029	2.1%	14263	2.1%	14370	2.1%	1774	0.3%

SHETUCKET BASIN

Basin Land Cover – 1985, 2010, and Change.

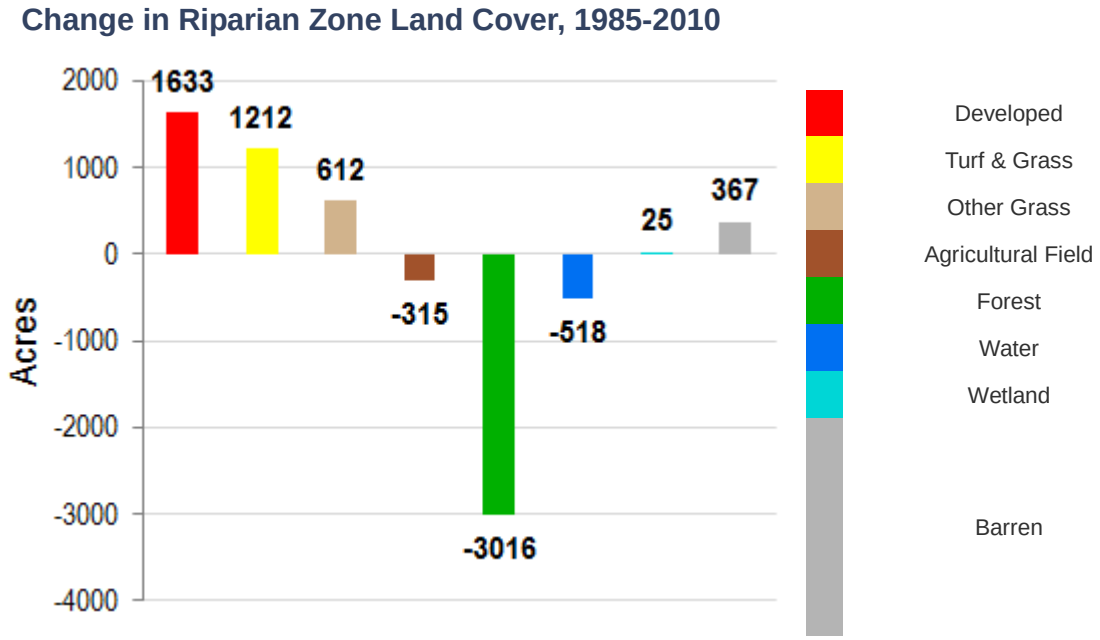
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	29159	8.7%	35794	10.6%	6636	2.0%
Turf & Grass	9255	2.7%	13715	4.1%	4460	1.3%
Other Grass	3630	1.1%	5780	1.7%	2150	0.6%
Ag. Field	27553	8.2%	25708	7.6%	-1845	-0.5%
Deciduous Forest	204182	60.6%	193908	57.6%	-10274	-3.1%
Coniferous Forest	36979	11.0%	35937	10.7%	-1042	-0.3%
Water	9679	2.9%	8885	2.6%	-793	-0.2%
Non-forested Wetlands	1606	0.5%	1622	0.5%	16	0.0%
Forested Wetlands	12505	3.7%	11984	3.6%	-521	-0.2%
Tidal Wetlands	0	0.0%	0	0.0%	0	0.0%
Barren	1225	0.4%	2469	0.7%	1243	0.4%
Utility ROW (Forest)	1024	0.3%	995	0.3%	-29	0.0%



SHETUCKET BASIN

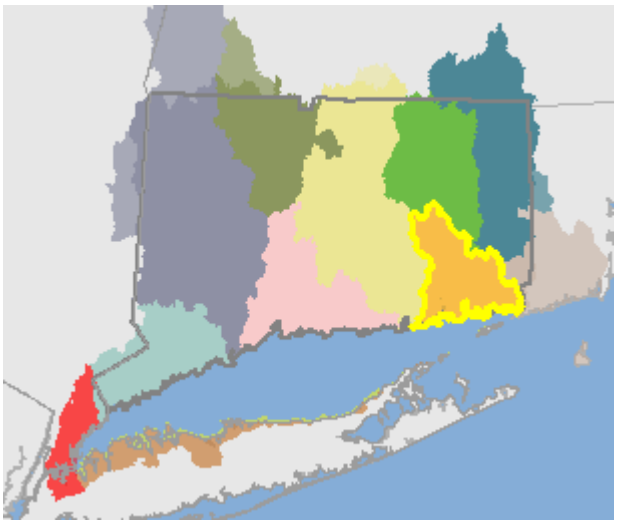
Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	8957	8.8%	10590	10.5%	1633	1.6%
Turf & Grass	2560	2.5%	3772	3.7%	1212	1.2%
Other Grass	1087	1.1%	1699	1.7%	612	0.6%
Ag. Field	7166	7.1%	6851	6.8%	-315	-0.3%
Deciduous Forest	57365	56.6%	54994	54.3%	-2370	-2.3%
Coniferous Forest	12032	11.9%	11751	11.6%	-281	-0.3%
Water	3304	3.3%	2786	2.7%	-518	-0.5%
Non-forested Wetlands	875	0.9%	900	0.9%	25	0.0%
Forested Wetlands	7401	7.3%	7044	7.0%	-357	-0.4%
Tidal Wetlands	0	0.0%	0	0.0%	0	0.0%
Barren	332	0.3%	698	0.7%	367	0.4%
Utility ROW (Forest)	252	0.2%	245	0.2%	-7	0.0%



THAMES BASIN

The total area of the Thames River Basin is approximately 369 square miles (236,102 acres).



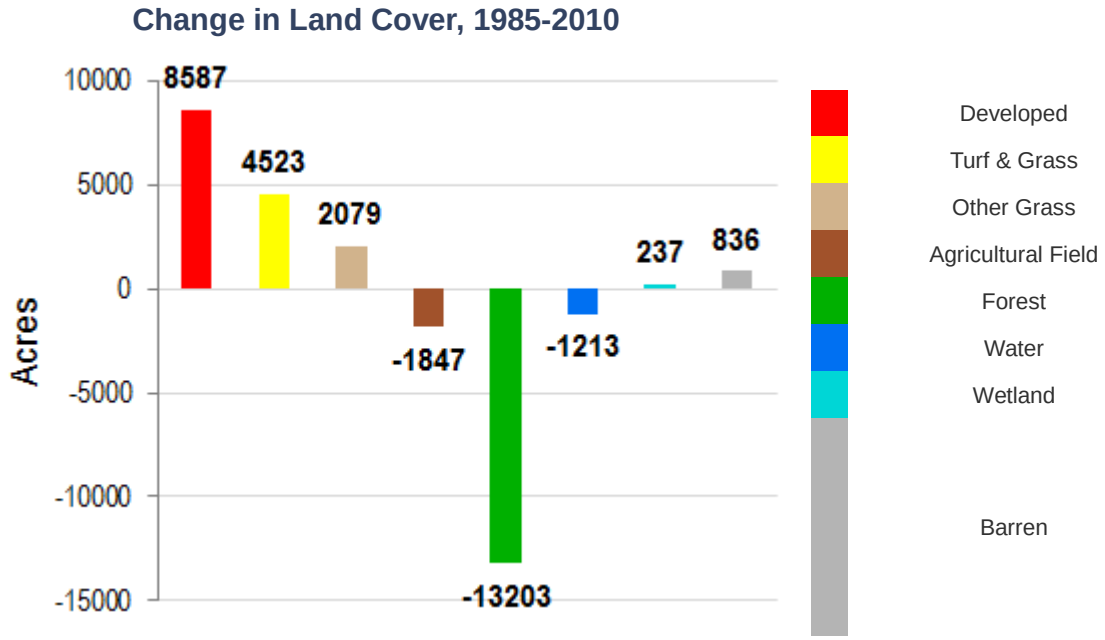
Thames River Basin Impervious Cover Analysis.

1985		1990		1995		2002		2006		2010		Change	
acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%
13296	2.0%	13969	2.1%	14398	2.1%	15045	2.2%	15333	2.3%	15585	2.3%	2289	0.3%

THAMES BASIN

Basin Land Cover – 1985, 2010, and Change.

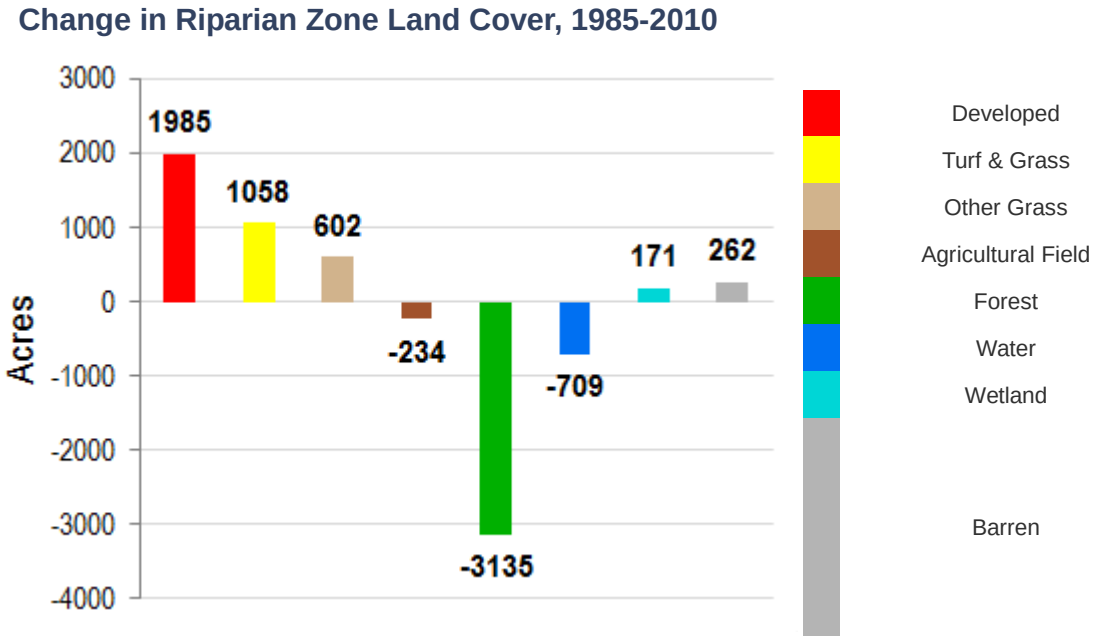
	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	32935	13.9%	41522	17.6%	8587	3.6%
Turf & Grass	10470	4.4%	14993	6.4%	4523	1.9%
Other Grass	3700	1.6%	5779	2.4%	2079	0.9%
Ag. Field	18195	7.7%	16348	6.9%	-1847	-0.8%
Deciduous Forest	132001	55.9%	120060	50.9%	-11940	-5.1%
Coniferous Forest	8326	3.5%	7591	3.2%	-735	-0.3%
Water	11659	4.9%	10446	4.4%	-1213	-0.5%
Non-forested Wetlands	1010	0.4%	1051	0.4%	41	0.0%
Forested Wetlands	12859	5.4%	12402	5.3%	-457	-0.2%
Tidal Wetlands	1442	0.6%	1638	0.7%	196	0.1%
Barren	1820	0.8%	2656	1.1%	836	0.4%
Utility ROW (Forest)	1685	0.7%	1615	0.7%	-71	0.0%



THAMES BASIN

Riparian Zone Land Cover – 1985, 2010, and Change.

	1985		2010		Change	
	acres	%	acres	%	acres	%
Developed	8649	12.3%	10633	15.1%	1985	2.8%
Turf & Grass	2587	3.7%	3645	5.2%	1058	1.5%
Other Grass	1040	1.5%	1642	2.3%	602	0.9%
Ag. Field	4290	6.1%	4056	5.8%	-234	-0.3%
Deciduous Forest	39215	55.7%	36508	51.9%	-2708	-3.8%
Coniferous Forest	2654	3.8%	2519	3.6%	-135	-0.2%
Water	2214	3.1%	1505	2.1%	-709	-1.0%
Non-forested Wetlands	641	0.9%	665	0.9%	24	0.0%
Forested Wetlands	7653	10.9%	7374	10.5%	-278	-0.4%
Tidal Wetlands	377	0.5%	524	0.7%	148	0.2%
Barren	581	0.8%	843	1.2%	262	0.4%
Utility ROW (Forest)	476	0.7%	462	0.7%	-14	0.0%



Appendix E
Connecticut Department of Energy and Environmental Protection
Timeline of Water Management Programs

Timeline of Water Management Programs

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Stormwater General Permits																							
Industrial Activities																					X		
Commercial Activities																				X			
Construction Activities																				X			
Phase I MS4																							
Phase II MS4																							
NP& Point Stormwater Support																							
Guidelines for Soil Erosion & Sediment Control													X										
Stormwater Quality Manual																							
LID Report & Appendices																							
CTDOT SWMP																							
Nonpoint Source Stormwater																							
Coastal Mgt Act-Site Plan Reviews																							
PA-170 & PA 398 Concerning LIS																							
Clean Vessel Act																							
Clean Marina Program																							
UCONN CLEAR-NEMO																							
UCONN Pest-Turf Mgt																							
Agriculture																							
Nutrient Management Plans																							
State Environmental Assistance Prog.																							
Federal NRCS EQIP																							
Combination																							
319 Grant Funded Projects																							
Watershed Planning Projects																							

X indicates most recent renewal