Draft
Westport River Estuarine System
Total Maximum Daily Loads
For Total Nitrogen
(CN-375.0)

COMMONWEALTH OF MASSACHUSETTS
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October 2015

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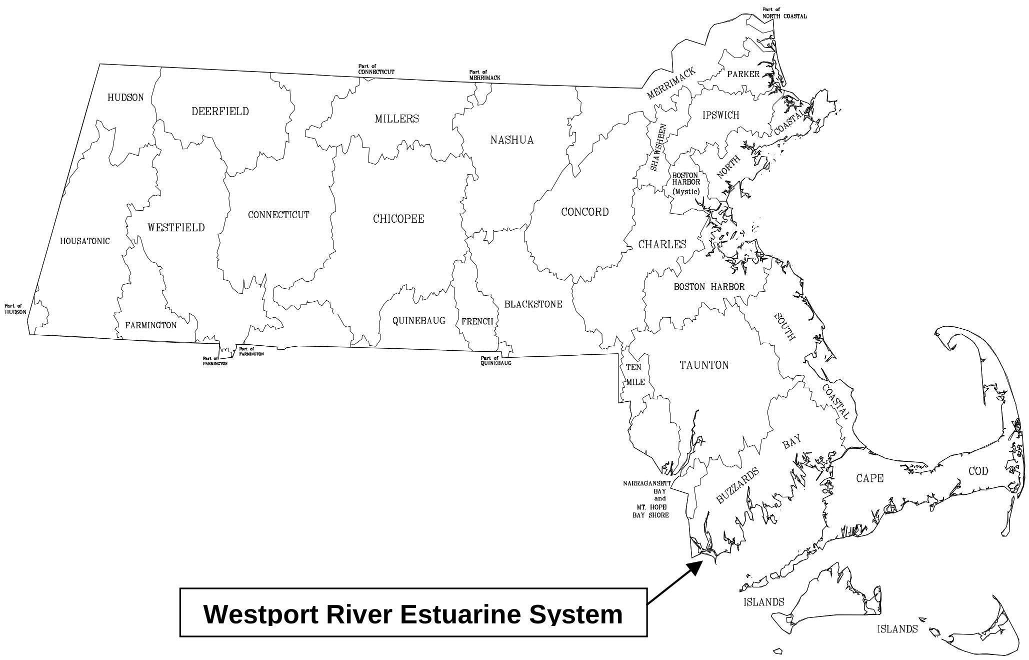


Key Feature: Total Nitrogen TMDLs for the Westport River Estuarine System

Location: EPA Region 1, Westport, MA

Land Type: New England Coastal

303d Listing: The water body segments impaired for TN and on the Category 5 list of the 2012 MA Integrated List of Waters include: East Branch Westport River (MA95-41); West Branch Westport River (MA95-37); Westport River (MA95-54)

Data Sources: University of Massachusetts – Dartmouth/School for Marine Science and Technology (SMAST); US Geological Survey; Applied Coastal Research and Engineering, Inc.; Towns of Dartmouth and Westport

Data Mechanism: Massachusetts Surface Water Quality Standards, Ambient Data, and Linked Watershed Model

Monitoring Plan: Coalition for Buzzards Bay, Bay Watcher Program; Westport River Watershed Alliance; technical assistance from SMAST

Control Measures: Agricultural BMPs, Sewering, Stormwater Management, Attenuation by Impoundments and Wetlands, Fertilizer Use By-laws

Executive Summary

Problem Statement

Excessive nitrogen (N) originating from a range of sources has added to the impairment of the environmental quality of the Westport River Estuarine System. Excessive N is indicated by:

- Undesirable increases in macro algae
- Periodic extreme decreases in dissolved oxygen concentrations that threaten aquatic life
- Loss of eelgrass
- Reductions in the diversity of benthic animal populations
- Periodic algae blooms

With proper management of N inputs these trends can be reversed. Without proper management more severe problems might develop, including:

- Periodic fish kills
- Unpleasant odors and scum
- Benthic communities reduced to the most stress-tolerant species, or in the worst cases, near loss of the benthic animal communities

Coastal communities rely on clean, productive, and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing, and boating, as well as for commercial fin fishing and shellfishing. Failure to reduce and control N loadings could result in an overabundance of macro-algae, a higher frequency of extreme decreases in dissolved oxygen concentrations and fish kills, widespread occurrence of unpleasant odors and visible scum, and a complete loss of benthic macroinvertebrates throughout most of the embayments. As a result of these environmental impacts, commercial and recreational uses of the Westport River Estuarine System will be greatly reduced.

Sources of Nitrogen

Nitrogen enters the waters of coastal embayments from the following sources:

- The watershed
  - Natural background
  - Septic Systems
  - Runoff
  - Landfills
  - Fertilizers/Agriculture
  - Wastewater treatment facilities
- Atmospheric deposition
- Nutrient-rich bottom sediments in the embayments

Figure ES-A and Figure ES-B illustrate the percent contribution of all the sources of N and the controllable N sources to the estuary system, respectfully. Values are based on Table IV-2 and

Figure IV-6 from the Massachusetts Estuaries Project (MEP) Technical Report. As evident, most of the present *controllable* load to this system comes from agriculture and septic systems.

Figure ES-A: Percent Contributions of All Nitrogen Sources to the Westport River Estuarine System

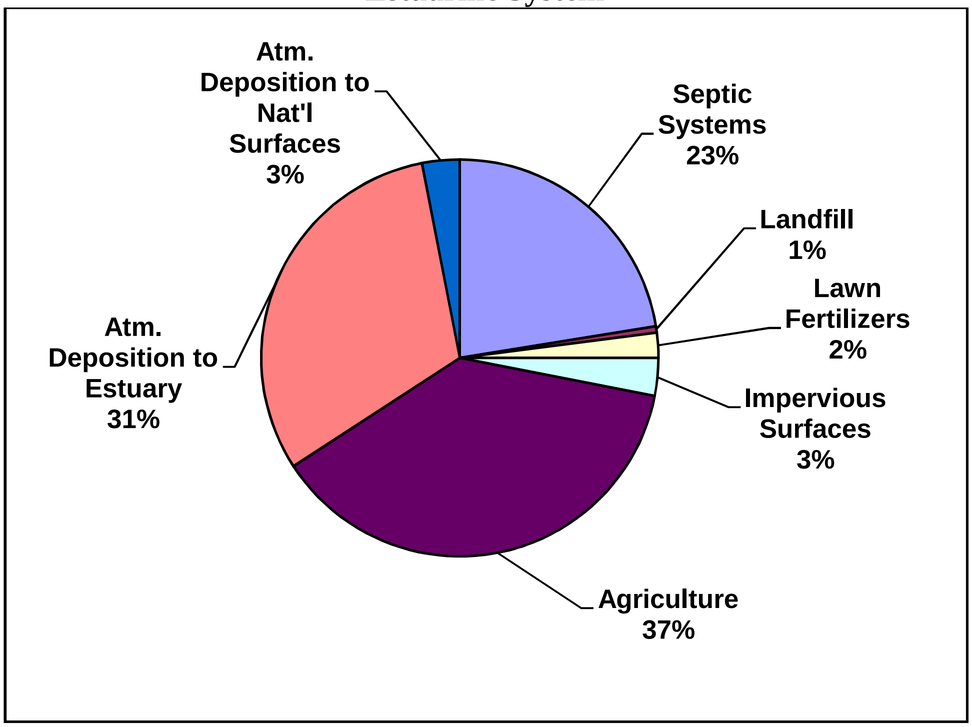
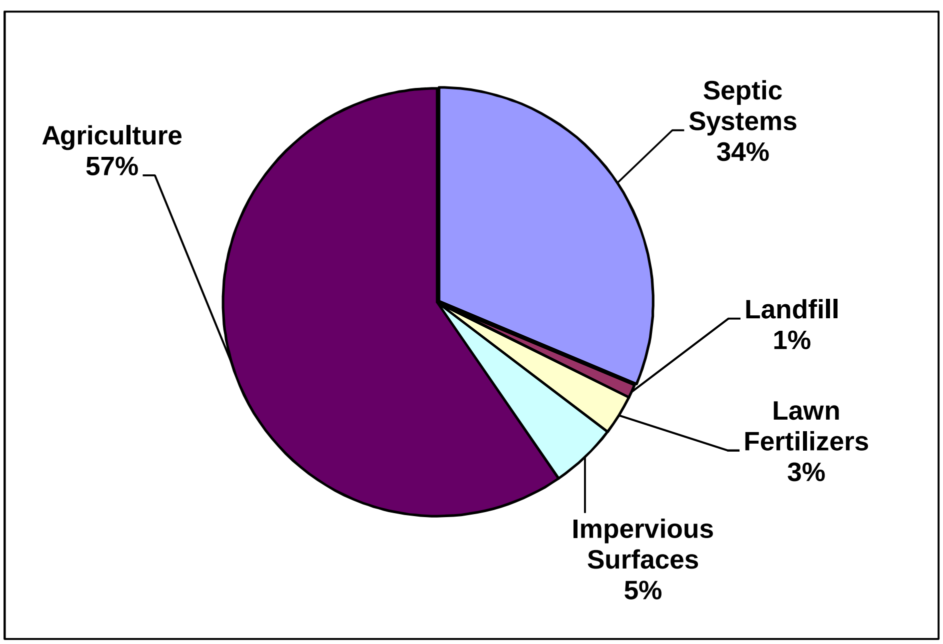


Figure ES-B: Percent Contributions of Controllable N Sources to the Westport River Estuarine System



Target Threshold N Concentrations and Loadings

The N loadings (the quantity of N) to this system ranged from 162.61 kg/day in the Old County Road subwatershed to 8.14 kg/day in Snell Creek, with total (attenuated) loads for the Westport River Estuarine System of 546.39 kg N/day (see Howes *et. al* 2013, Table ES-1). The resultant concentrations of N ranged from 0.449 mg/l in the lower portion (most downstream) of the West Branch Westport River to1.44 mg/L in the head of the Westport (range of average annual means collected from 14 stations during 2003-2009 as reported in Table VI-1 of the MEP Technical Report (Howes *et. al* 2013), and included in Appendix B of this report).

In order to restore and protect this estuarine system, N loadings, and subsequently the concentrations of N in the water, must be reduced to levels below those that cause the observed environmental impacts. This N concentration will be referred to as the *target threshold N concentration*. The Massachusetts Estuaries Project (MEP) has determined that by achieving a N concentration at sentinel stations water and habitat quality will be restored in these systems. The mechanism for achieving the target threshold N concentrations is to reduce the N loadings to the watershed of the harbor estuarine system. Based on the MEP sampling and modeling analyses and their Technical Report, the MEP study has determined that the Total Maximum Daily Loads (TMDL) of N that will meet the target threshold N concentration of 0.49 mg/L for the East Branch and 0.48 mg/L for the West Branch range from 3.58 kg/day in the Snell Creek subwatershed to 111.82 kg/day in the Old County Road subwatershed (Appendix D). The MEP has determined that the Westport Estuarine System will require four TMDLs and six "pollution prevention" TMDLs to restore or maintain water quality. Appendix D lists the sub-embayment, Segment Identification and the TMDL in kg N/day.

Six water body segments were not found to be impaired for nitrogen, but it was determined that a "pollution prevention" TMDL for nitrogen was needed since these waterbody segments are linked to the larger embayment system and any future impairment of these segments could further contribute to impairment of the segments at issue in this TMDL (Appendix D). "Pollution prevention" TMDLs on these six waterbody segments will encourage the maintenance and protection of existing water quality and help prevent further degradation to waterbodies that are downstream or linked. These pollution prevention TMDLs will serve as a guide to help ensure that these waterbodies do not become impaired for nitrogen.

To meet these TMDLs the MEP Technical Report recommends a reduction of 71% of the septic load for the entire system, assuming the landfill loads from the Old County Road and East Branch (North) subwatersheds will be mitigated. This document presents the TMDLs for these water body systems and provides guidance to the watershed communities of Westport, Dartmouth, Fall River, and Freetown, MA and Tiverton and Little Compton, RI on possible ways to reduce the N loadings to within the recommended TMDL and protect the waters of these embayment systems.

Implementation

The primary goal of TMDL implementation will be lowering the concentrations of N by reducing the loadings from on-site subsurface wastewater disposal systems by 100% in the following subwatershed areas: East Branch (North), East Branch (South), Old County Road, Kirby Brook and Snell Creek. Reductions of the loadings from on-site subsurface wastewater disposal systems can be achieved through a variety of centralized or decentralized methods such as sewering and treatment with N removal technology, advanced treatment of septage, and/or installation of N-reducing on-site systems. However, there is a variety of loading reduction scenarios that could achieve the target threshold N concentrations. Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Wastewater Management Plan (CWMP). In addition, nitrogen loads from landfills located in the Old County Road and East Branch (North) subwatersheds are currently being mitigated. It is expected that these landfill nitrogen loads will likely be eliminated and therefore these TMDLs are calculated based on that assumption.

Since agriculture was found to contribute the largest controllable N load (57%) to this system it is recommended that the watershed communities implement agricultural best management practices (BMPs) with a goal of reducing N contribution from agricultural sources by 10% watershed-wide. The watershed communities should request an additional model run from SMAST that considers a scenario that includes recommendations for reductions in agriculture N loads, as well as, septic loads from the various subembayments. This will help focus agricultural BMP implementation activities to areas that will most effectively reduce N loads and perhaps reduce the need for sewering. In particular, the percentage contribution of agriculture N load from the subwatersheds of the North East Branch, West Branch, Old County Road and Angeline Creek ranged from 38% to as much as 81% of the watershed N load. The MEP Technical report TMDL scenario recommends 100% removal of the septic load from North East Branch and Old County Road subwatersheds. However, reducing agriculture N loads from these subwatersheds, even by just 10%, will aid in meeting nutrient reduction targets within the estuaries and diminish the need for 100% reduction of septic load.

Implementing best management practices (BMPs) to reduce N loadings from lawn fertilizers and runoff where possible will also help to lower the total N load to these systems. Potential methods for reducing N loadings from these sources are explained in detail in the MEP "Embayment Restoration and Guidance for Implementation Strategies" that is available on the MassDEP website: http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html. The appropriateness of any of the alternatives will depend on local conditions and will have to be determined on a case-by-case basis using an adaptive management approach.

Finally, growth within the watershed towns of Westport, Fall River, Freetown and Dartmouth that would exacerbate the problems associated with N loadings, should be guided by considerations of water quality-associated impacts.

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Introduction

Section 303(d) of the Federal Clean Water Act requires each state to identify waters that are not meeting water quality standards and to establish Total Maximum Daily Loads (TMDLs) for such waters for the pollutants of concern. The TMDL allocation establishes the maximum loadings (of pollutants of concern) from all contributing sources that a water body may receive and still meet and maintain its water quality standards and designated uses, including compliance with numeric and narrative standards. The TMDL development process may be described in four steps, as follows:

1. Determination and documentation of whether or not a water body is presently meeting its water quality standards and designated uses.

2. Assessment of present water quality conditions in the water body, including estimation of present loadings of pollutants of concern from both point sources (discernable, confined, and concrete sources such as pipes) and non-point sources (diffuse sources that carry pollutants to surface waters through runoff or groundwater).

3. Determination of the loading capacity of the water body. EPA regulations define the loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. If the water body is not presently meeting its designated uses, then the loading capacity will represent a reduction relative to present loadings.

4. Specification of load allocations, based on the loading capacity determination, for non-point sources and point sources that will ensure that the water body will not violate water quality standards.

After public comment and final approval by the EPA, the TMDL will serve as a guide for future implementation activities. The MassDEP will work with the watershed towns of Westport, Fall River, Freetown and Dartmouth to develop specific implementation strategies to reduce N loadings, and will assist in developing a monitoring plan for assessing the success of the nutrient reduction strategies. The Westport River watershed towns of Tiverton and Little Compton in Rhode Island will also be encouraged to participate in discussions regarding implementation strategies to reduce nitrogen loadings to the estuary system.

In the Westport River Estuarine System the pollutant of concern for these TMDLs (based on observations of eutrophication) is the nutrient nitrogen. Nitrogen is the limiting nutrient in coastal and marine waters, which means that as its concentration is increased so is the amount of plant matter. This leads to nuisance populations of macro-algae and increased concentrations of phytoplankton and epiphyton which impairs the healthy ecology of the affected water bodies.

The TMDLs for total N for the Westport River Estuarine System are based primarily on data collected, compiled and analyzed by University of Massachusetts Dartmouth's School of Marine Science and Technology (SMAST) Coastal Systems Program as part of the Massachusetts Estuaries Project (MEP) and the Coalition for Buzzards Bay BayWatcher water quality monitoring program. The data used in this report were collected over a study period from 2003 through 2009. This study period will be referred to as the "present conditions" in the TMDL report since it contains the most recent data available. The accompanying MEP Technical Report can be found at http://www.oceanscience.net/estuaries/reports.htm.

The MEP Technical Report presents the results of the analyses of the coastal embayment systems using the MEP Linked Watershed-Embayment N Management Model (Linked Model). The analyses were performed to assist the watershed community with decisions on current and future wastewater planning, wetland restoration, anadromous fish runs, shellfisheries, open-space and harbor maintenance programs. A critical element of this approach is the assessment of water quality monitoring data, historical changes in eelgrass distribution, time-series water column oxygen measurements and benthic community structure that was conducted on this embayment. These assessments served as the basis for generating a N loading threshold for use as a goal for watershed N management. The TMDLs are based on the site specific N threshold generated for this estuarine system. Thus, the MEP offers a science-based management approach to support the wastewater management planning and decision-making process in the watershed communities of Westport, Dartmouth, Freetown and Fall River in Massachusetts as well as the watershed towns of Tiverton and Little Compton in Rhode Island.

Description of Water Bodies and Priority Ranking

The Westport River Estuarine System is located in southeastern Massachusetts on the Massachusetts-Rhode Island state boundary. The system is comprised of two river valley estuaries (east and west branches), a coastal lagoon (Westport Harbor) and a relict tidal inlet (The Let) (Figure 1). Westport Harbor is situated at the confluence of the east and west branches and exchanges tidal waters with Buzzards Bay through a single tidal inlet to the southwest. The Westport River Estuary and much of its watershed are located primarily within the Town of Westport. The estuary watershed extends north into Freetown and the city of Fall River and east into the town of Dartmouth as well as westerly, encompassing small areas in Tiverton and Little Compton, RI. (Figure 2)

The principal surface water inflows are the Westport River which discharges into the head of the East Branch and accounts for >67% of the total freshwater input to the east branch and Adamsville Brook discharging to the head of the west branch and accounting for 58% of the total freshwater inflow to this basin. Other notable fresh water streams that discharge to the estuary include East Branch tributaries Kirby Brook and Snell Creek, and Angeline Brook discharging to the West Branch.

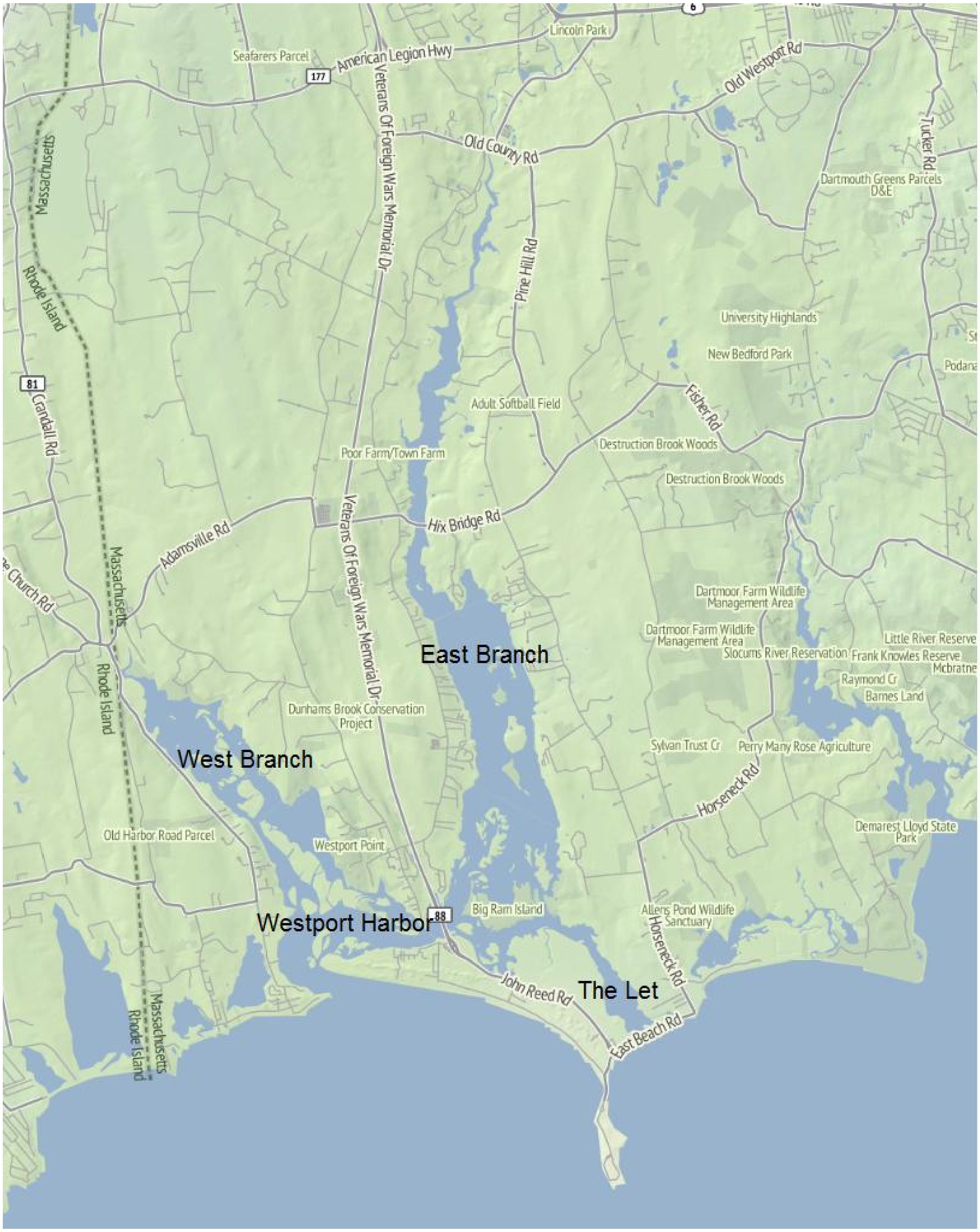


Figure 1: Westport River Embayment System
(map made via ggmap, courtesy Kahle and H. Wickham 2013)

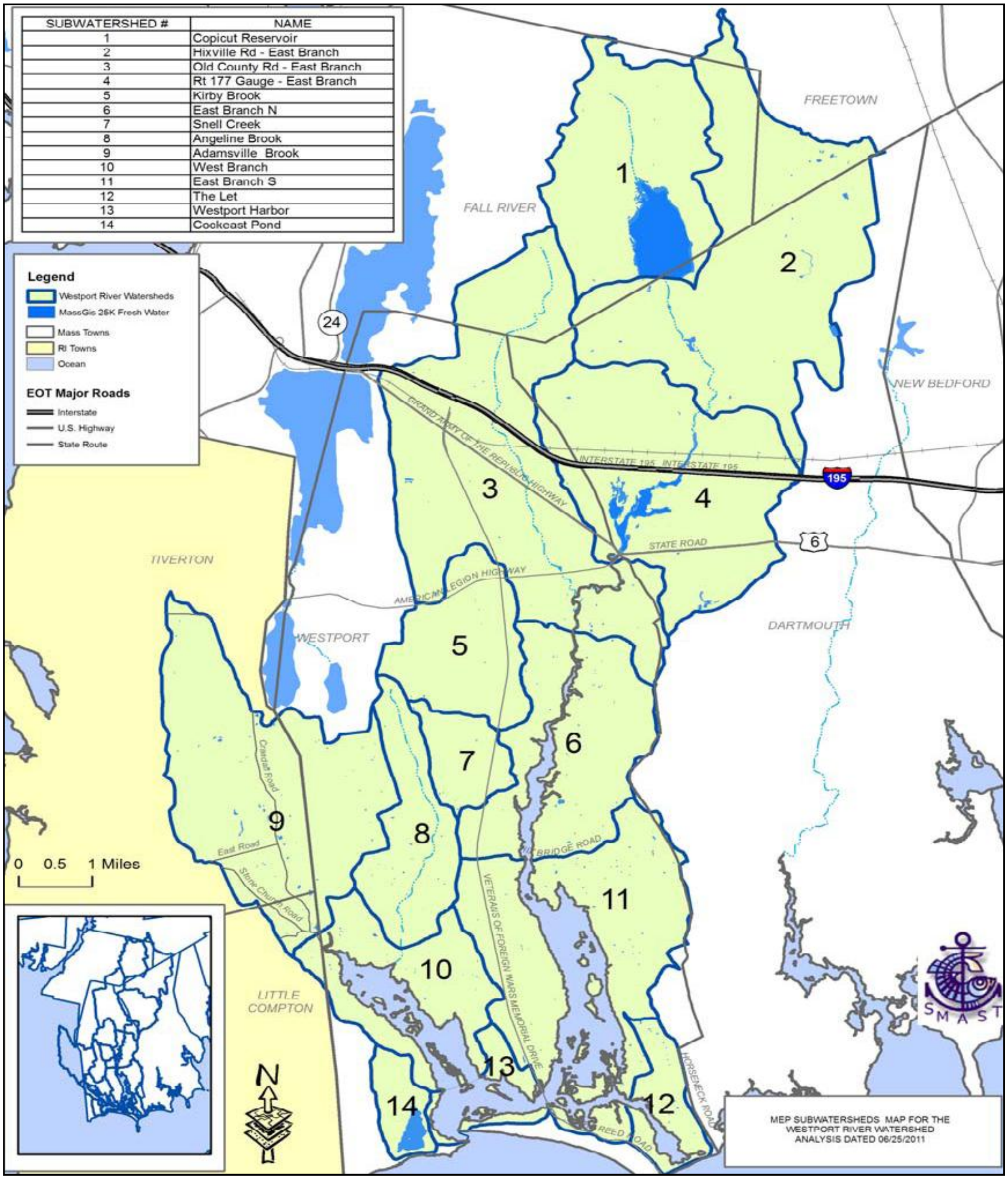


Figure 2: Westport River Watershed and Sub-watershed Delineations
(excerpted from Howes et. al, 2013)

The MEP project assessed landuse in the Westport River embayment system using town assessor's digital parcel data from the towns of Westport, Dartmouth, Freetown and the city of Fall River as well as the Rhode Island towns of Tiverton and Little Compton. The Rhode Island towns land use codes were translated to similar MassDOR (2009) land use codes for consistency. Landuse was summarized into nine categories including residential, commercial, industrial, agricultural, recreational, undeveloped, forest, unclassified and public service/government (including rights of way). The landuse summary follows Massachusetts Department of Revenue classifications (MassDOR 2009) and the public service category signifies tax exempt properties including land owned by government and private non-profits. The most common landuse categories are residential and public service which comprised 32% and 25% of the overall Westport watershed respectively (Howes *et. al* 2013, pg. 31). The watershed is projected to have an additional 4,328 residences at buildout which would "increase the unattenuated nitrogen loading rate by 26%" (Howes et. al 2013, pg. 53).

This estuarine system constitutes an important component of the area's natural and cultural resources. The nature of enclosed embayments in populous regions brings two opposing elements to bear: 1) as protected marine shoreline, they are popular regions for boating, recreation, and land development; and 2) as enclosed bodies of water, they may not be readily flushed of the pollutants that they receive due to the proximity and density of development near and along their shores.

In particular, the Westport River estuarine system is at risk of further eutrophication from high nutrient loads in the groundwater and runoff from their watersheds. Both East and West branches of the Westport River as well as the Westport River are already listed as impaired for nutrients and requiring a TMDL (Category 5) in the MA 2012 Integrated List of Waters (MassDEP 2013). Table 1 summarizes the MEP waterbodies and the corresponding MassDEP segments listed in Category 5 in the MassDEP 2012 Integrated List as well as the impairments that were observed through the MEP analysis. For the purpose of assessing the ecological health of the Westport River Estuarine System the East Branch was divided into three parts (Upper, Middle, Lower; see Table 2) during MEP analysis. Analysis of the ecological health of the West Branch was conducted by divided the waterbody into two parts (Upper, Lower; see Table 2). The areas analyzed by MEP for ecological health have been consolidated in Table 1 below to correspond with their respective subembayment as modeled for nitrogen loading analysis (see Table 4).

Table 1. Comparison of Westport River MEP Study Area Waterbodies in Category 5 of the MA 2012 Integrated List and SMAST Impaired Parameters

MEP Waterbody Name	MassDEP Segment Number (if applicable)	MassDEP Segment [Description]	Class	2012 Integrated List Category[1]	SMAST Impaired Parameter[2]	Size (acres)[2]
North East Branch	part of MA95-41	East Branch Westport River [Old County Road bridge, Westport to the mouth at Westport Harbor, Westport (excluding Horseneck Channel).]	SB (SFR)	-Nutrients -Estuarine Bioassessments -Pathogens *	-Nutrients -DO level -Chlorophyll -Eelgrass -Benthic fauna	311
South East Branch	part of MA95-41	East Branch Westport River [Old County Road bridge, Westport to the mouth at Westport Harbor, Westport (excluding Horseneck Channel).]	SB (SFR)	-Nutrients -Estuarine Bioassessments -Pathogens *	-Nutrients -Macroalgae -Chlorophyll -Eelgrass	1492
West Branch	MA95-37	West Branch Westport River [Outlet Grays Mill Pond, Adamsville, Rhode Island to mouth at Westport Harbor, Westport.]	SA (SFO)	-Nutrients -Estuarine Bioassessments -Pathogens *	-Nutrients -Macroalgae -Chlorophyll -Eelgrass -Benthic fauna	795
Westport Harbor	MA95-54	Westport River [From the confluences of the East Branch Westport River and the West Branch Westport River to Rhode Island Sound (at a line from the southwestern tip of Horseneck Point to the easternmost point near Westport Light), Westport.]	SA (SFO)		-DO level	484

* A TMDL for pathogens has been approved for Buzzards Bay (ENSR International 2009)
SFO - Shellfishing Open
SFR – Shellfishing Restricted

1- See (MassDEP 2013)

2- As calculated/determined during MEP project (Howes et. al, 2013)

In its 2000 Buzzards Bay Water Quality Assessment Report (http://www.mass.gov/eea/agencies/massdep/water/watersheds/water-quality-assessments.html#3) MassDEP assessed the Westport River (segment MA95-54) as impaired based on eelgrass loss that occurred from 1951 – 1994. The more recent MEP analysis found unimpaired water quality and stable eelgrass beds in the Westport River so the segment will be evaluated for future delisting. MassDEP also lists these waterbodies as impaired for pathogens and other habitat alterations. This information is included in Table 1 for completeness; however, further discussion of these pollutants is beyond the scope of this TMDL.

The majority of information presented here and used to develop this TMDL is drawn the MEP Technical Report (Howes *et. al*, 2013). A complete description of this embayment system is presented in Chapters I and IV of the report. Chapters VI and VII of the MEP Technical Report provide assessment data that show that areas of the Westport River estuarine system are impaired because of elevated nutrients, low dissolved oxygen levels, elevated chlorophyll *a* levels, eelgrass loss and impaired benthic fauna habitat.

The embayment addressed by this document has been determined to be "high priority" based on three significant factors: (1) the initiative that the Town of Westport has taken to assess the conditions of the entire embayment system; (2) the commitment made by the town to restore the Westport River estuarine system; and (3) the extent of impairment in the Westport River estuarine system. In both marine and freshwater systems an excess of nutrients results in degraded water quality, adverse impacts to ecosystems and limits on the use of water resources. Observations are summarized in the Problem Assessment section below and detailed in Chapter VII, Assessment of Embayment Nutrient Related Ecological Health, of the MEP Technical Report.

Problem Assessment

Water quality problems associated with development within this watershed result primarily from agricultural activities and septic systems, and to a lesser extent stormwater runoff, lawn fertilizers and landfills.

The water quality problems affecting nutrient-enriched embayments generally include periodic decreases of dissolved oxygen, loss of eelgrass beds, decreased diversity and quantity of benthic animals and periodic algae blooms. In the most severe cases habitat degradation could lead to periodic fish kills, unpleasant odors and scums and near loss of the benthic community and/or presence of only the most stress-tolerant species of benthic animals.

Coastal communities, including Westport, rely on clean, productive and aesthetically pleasing marine and estuarine waters for tourism, recreational swimming, fishing and boating, as well as commercial fin fishing and shell fishing. The continued degradation of this coastal embayment, as described above, will significantly reduce the recreational and commercial value and use of these important environmental resources.

Figure 3 shows how the population of Westport has almost quadrupled from about 4,000 people in 1930 to over 15,500 people in 2010. Dartmouth shows a similar pattern of population increase during this period. Increases in N loading to estuaries are directly related to increasing development and population in the watershed. This increase in population contributes to a decrease in undeveloped land and an increase in septic systems, runoff from impervious surfaces and fertilizer use. Although a portion of the Westport River watershed is connected to the Town of Dartmouth sewer collection system (which discharges outside of the watershed) most of the watershed is serviced by septic systems. These unsewered areas contribute significantly to the system through transport in direct groundwater discharges to estuarine waters and through surface water flows.

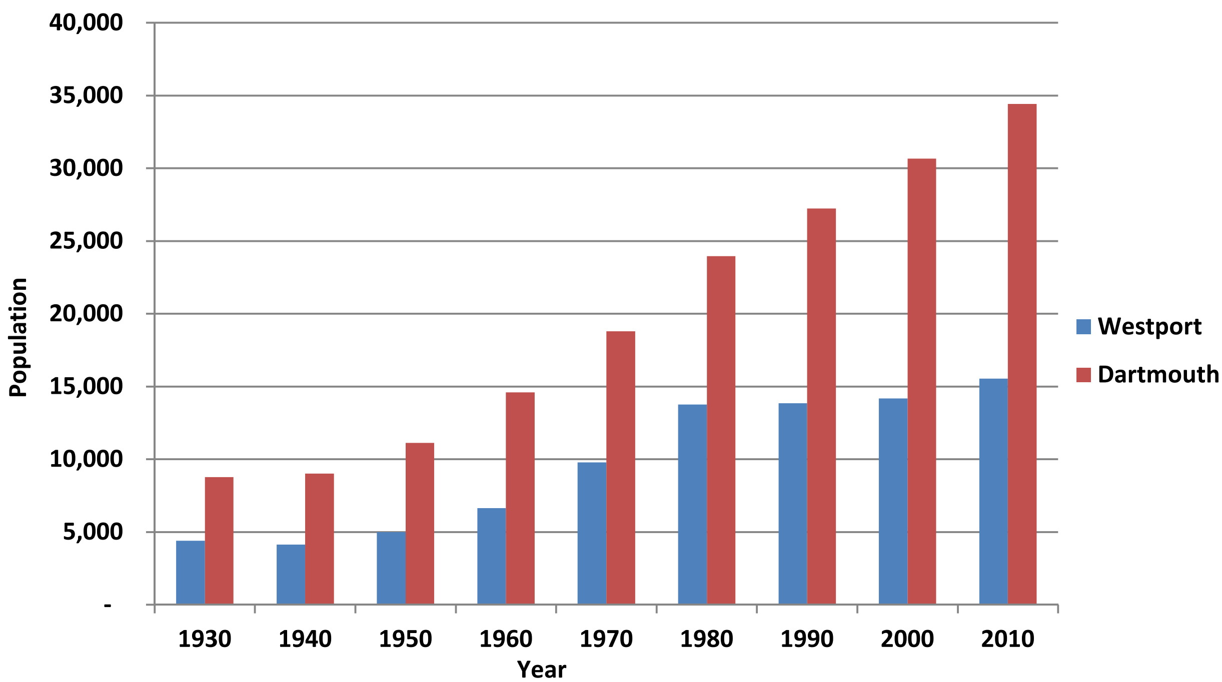


Figure 3: Resident Population for Westport and Dartmouth
http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

Habitat and water quality assessments were conducted on this estuarine system based upon water quality monitoring data, changes in eelgrass distribution, time-series water column oxygen measurements and benthic community structure. The MEP evaluation of habitat quality supported by each area considers its natural structure and its ability to support eelgrass beds and the types of infaunal communities that they support.

The Westport River estuary is a complex estuary composed of 3 functional types of basins: shallow open water basins with no eelgrass or surrounding wetland, shallow basins with significant associated salt marsh and eelgrass, and an estuarine lagoon with high tidal velocities and areas of shifting sands (Westport Harbor). Each of these 3 basin types is different in its natural sensitivity to nitrogen enrichment and organic matter loading and each has its own benthic community indicative of an unimpaired or impaired habitat as well as different abilities to support stable eelgrass beds.

Overall, the estuary is showing some nitrogen related habitat impairment within some of its component basins, however, most of the system is supporting high quality to moderately impaired habitat, with regions of significant impairment resulting primarily from the loss of eelgrass coverage (e.g. mid reach East Branch) or degraded benthic animal habitat (upper East Branch) (Table 2). The benthic animal communities throughout most of the Westport River estuary (except upper to mid East Branch) indicate generally healthy infaunal habitat, consistent with the tidally averaged nitrogen levels and levels of oxygen depletion for the ecosystem types represented. All of the eelgrass information for the Westport River estuary indicates that the eelgrass habitat is significantly impaired in the upper reaches of the East and West Branches and moderately impaired in the mid-regions, with stable high quality eelgrass beds in the lower regions near and including Westport Harbor.

This is a typical pattern of eelgrass loss associated with nitrogen loading, with eelgrass being lost from the uppermost regions of each basin and the deeper waters first, appearing to "retreat" toward the inlet. The results indicate that eelgrass has been lost from the Westport River estuary in areas that presently support tidally averaged N levels of 0.57 mg/L and >0.50 mg/L in the East and West Branches, respectively. At lower nitrogen levels eelgrass is persisting, but with epiphytes and losses of coverage from the upper and deeper areas of the beds. These sites are associated with N levels of 0.51 mg/L and ~0.50 mg/L in the East and West Branches, respectively, while "healthy" beds are found at lower concentrations, with <0.428 mg/L and 0.421 mg/L in the East and West Branches, respectively, and <0.400 mg/L in Westport Harbor.

Oxygen and chlorophyll *a* levels were generally consistent with the eelgrass and infaunal animal assessments and paralleled gradients in nitrogen enrichment. The upper and middle section of the East Branch of the Westport River has large daily oxygen excursions, with moderate to significant oxygen depletion consistent with the significant level of nitrogen enrichment. The salt marsh influenced lower East Branch showed lower nitrogen levels and less oxygen depletion than the upper and mid reaches. This parallels the level of nitrogen enrichment with the lower East Branch showing higher oxygen levels and The Let showing moderate oxygen depletions consistent with its function as a salt marsh basin. However, the chlorophyll *a* and nitrogen levels within The Let indicate high water quality that supports both stable eelgrass beds and high quality benthic animal habitat. The observed levels of oxygen depletion within The Let (and to a lesser extent the lower East Branch) are typical of salt marsh ponds and therefore do not indicate impairment of this basin. Westport Harbor has high water quality and stable eelgrass beds. The West Branch shows a similar gradient in oxygen depletion as the East Branch, but as it is less nitrogen enriched, the levels of depletion are smaller and less frequent than the East Branch. However, given the frequent large phytoplankton blooms within the upper West Branch and patches of moderately impaired benthic animal habitat with some macroalgal accumulations, it appears that this reach is just above its ability to assimilate additional nitrogen and is showing initial signs of impairment by nitrogen enrichment.

Pollutant of Concern, Sources, and Controllability

In the coastal embayments of the Town of Westport, as in most marine and coastal waters, the limiting nutrient is N. Nitrogen concentrations beyond those expected naturally to contribute to undesirable conditions including the severe impacts described above, through the promotion of excessive growth of plants and algae, including nuisance vegetation.

The embayments addressed in this TMDL report have had extensive data collected and analyzed through the Massachusetts Estuaries Program (MEP) and with the cooperation and assistance from the Town of Westport, the USGS, and the Coalition for Buzzards Bay. Data collection included both water quality and hydrodynamics as described in Chapters I, IV, V, and VII of the MEP Technical Report.

Table 2: General Summary of Conditions Related to the Major Indicators of Habitat Impairment Observed in the Westport River Estuarine System

Health Indicator	Westport River Estuarine System						
	West Branch		East Branch			Westport Harbor	The Let
	Upper	Lower	Upper	Mid	Lower		
Dissolved Oxygen	H	H	MI-SI	MI-SI	H	H-MI	H
Chlorophyll	MI	H	MI-SI	MI-SI	H	H	H
Macroalgae	MI	MI	--	--	--	--	--
Eelgrass	_	H-MI	_	SI	H-MI	H	H
Infaunal Animals	H	H-MI	MI-SI	H	H	H	H
Overall	**H-MI**	**H-MI**	**SI**	**SI**	**H-MI**	**H**	**H**

H - Healthy Habitat Conditions*
MI – Moderately Impaired*
SI – Significantly Impaired- considerably and appreciably changed from normal conditions*
* - These terms are more fully described in MEP interim report "Site-Specific Nitrogen Thresholds for Southeastern Massachusetts Embayments: Critical Indicators" December 22, 2003
http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html
- drift algae sparse or absent
-- no evidence this basin is supportive of eelgrass

Figure 4a illustrates all of the sources of N to the Westport River estuarine system and Figure 4b shows just the controllable sources. As evident, the controllable N affecting these systems originates predominately from agricultural activities and on-site subsurface wastewater disposal systems (septic systems). The level of "controllability" of each source, however, varies widely:

<u>Agricultural Activities</u>, in this case one of the largest controllable sources of N, can be controlled by BMPs;

Atmospheric deposition– Although helpful, local controls are not adequate – it is only through region- and nation-wide air pollution control initiatives that significant reductions are feasible, however the N from these sources might be subjected to enhanced natural attenuation as it moves towards the estuary;

Fertilizer and related N loadings can be reduced through best management practices (BMPs), bylaws and public

Impervious surfaces and stormwater runoff sources of N can be controlled by BMPs, bylaws and stormwater infrastructure improvements and public education;

Landfill loads can be reduced by a variety of methods including lining, capping and mining.

Natural background - background load if the entire watershed was still forested and contained no anthropogenic sources. It cannot be controlled.

Septic system sources of N can be controlled by a variety of case-specific methods including: sewering and treatment at centralized or decentralized locations, transporting and treating septage at treatment facilities with N removal technology either in or out of the watershed, or installing N-reducing on-site wastewater treatment systems;

Cost/benefit analyses will have to be conducted on all possible N loading reduction methodologies in order to select the optimal control strategies, priorities and schedules. education;

Description of the Applicable Water Quality Standards

The water quality classification of the saltwater portion of Westport River estuary is SA except for the East Branch of the Westport River which is classified as SB (all surface waters subject to the rise and fall of the tide). The freshwater portions of the system are classified as B with the exception of Copicut Reservoir and its tributaries in the headwaters of the East Branch which are Class A.

Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, aesthetics, and excess plant biomass and nuisance vegetation. The Massachusetts water quality standards (314 CMR 4.0) contain numeric criteria for dissolved oxygen but have only narrative standards that relate to the other variables. The narrative standards for nutrients (nitrogen and phosphorus) for waters of the Commonwealth are such that "all surface waters shall be free of nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed site specific criteria developed in a TMDL or otherwise, established by the department" (MassDEP 2007). A more thorough explanation of applicable standards can be found in Appendix A. The freshwater waterbodies analyzed during the MEP project (Bread and Cheese Brook, Kirby Brook, Adamsville Brook, Angeline Creek and Snell Creek) are all considered Class B waterbodies. These waterbodies were not found to be impaired for total nitrogen (Appendix D) and therefore a summary of Class B criteria are not provided in Appendix A.

Figure 4a: Percent Contributions of All Nitrogen Sources to the Westport River Estuarine System

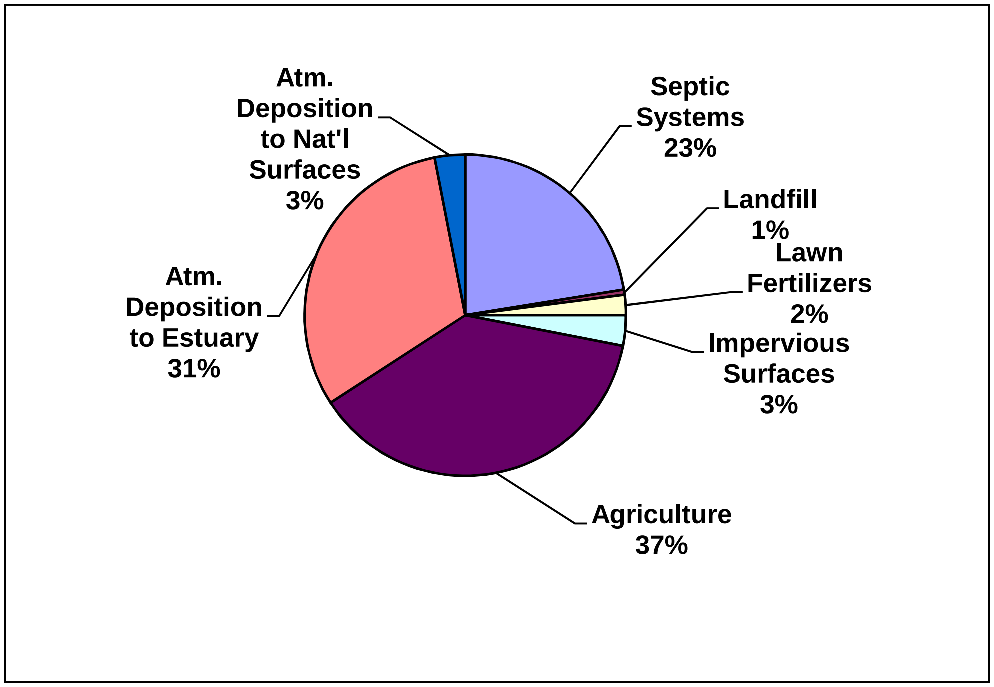
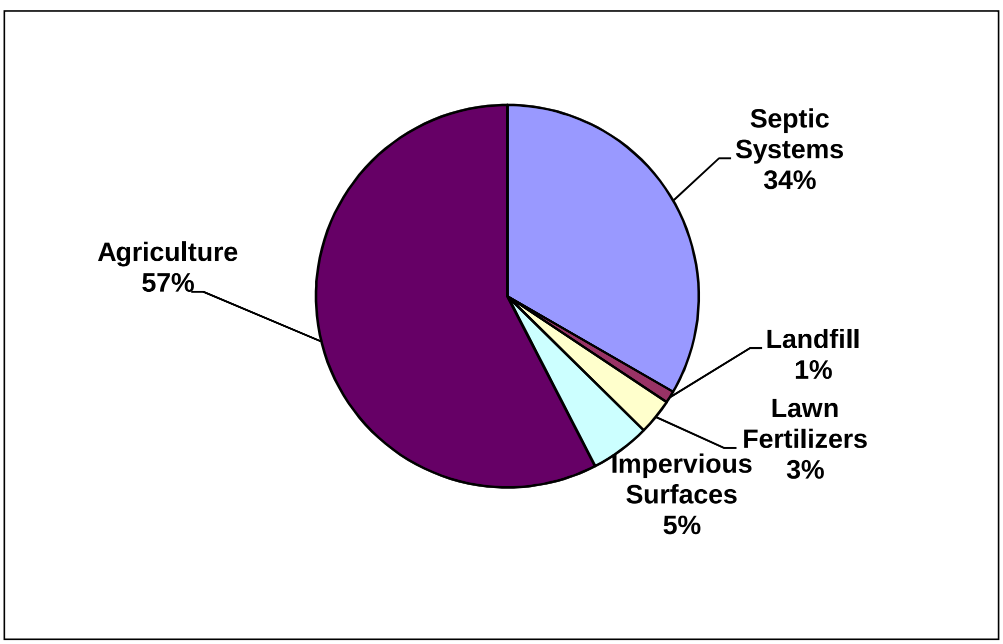


Figure 4b: Percent Contributions of Controllable N Sources to the Westport River Estuarine System



Thus, the assessment of eutrophication is based on site-specific information within a general framework that emphasizes impairment of uses and preservation of a balanced indigenous flora and fauna. This approach is recommended by the US Environmental Protection Agency in their Nutrient Criteria Technical Guidance Manual for Estuarine and Coastal Marine Waters (EPA-2001). The guidance Manual notes that lakes, reservoirs, streams, and rivers may be subdivided by classes, allowing reference conditions for each class and facilitating cost-effective criteria development for nutrient management. However, individual estuarine and coastal marine waters tend to have unique characteristics, and development of individual water body criteria is typically required.

Methodology - Linking Water Quality and Pollutant Sources

Extensive data collection and analyses have been described in detail in the MEP Technical Report. Those data were used by SMAST to assess the loading capacity of each embayment. Physical (Chapter V), chemical and biological (Chapters IV, VII, and VIII) data were collected and evaluated. The primary water quality objective was represented by conditions that:

1) Restore the natural distribution of eelgrass because it provides valuable habitat for shellfish and finfish;
2) Prevent harmful or excessive algal blooms;
3) Restore and preserve benthic communities;
4) Maintain dissolved oxygen concentrations that are protective of the estuarine communities.

The details of the data collection, modeling and evaluation are presented and discussed in Chapters IV, V, VI, VII and VIII of the MEP Technical Report. The main aspects of the data evaluation and modeling approach are summarized below.

The core of the Massachusetts Estuaries Project analytical method is the Linked Watershed-Embayment Management Modeling Approach. It fully links watershed inputs with embayment circulation and N characteristics, and is characterized as follows:

- Requires site specific measurements within the watershed and each sub-embayment;
- Uses realistic “best-estimates” of N loads from each land-use (as opposed to loads with built-in “safety factors” like Title 5 design loads);
- Spatially distributes the watershed N loading to the embayment;
- Accounts for N attenuation during transport to the embayment;
- Includes a 2D or 3D embayment circulation model depending on embayment structure;
- Accounts for basin structure, tidal variations, and dispersion within the embayment;
- Includes N regenerated within the embayment;
- Is validated by both independent hydrodynamic, N concentration, and ecological data;
- Is calibrated and validated with field data prior to generation of “what if” scenarios.

The Linked Model has been applied previously to watershed N management in over 50 embayments thus far throughout Southeastern Massachusetts. In these applications it became clear that the model can be calibrated and validated and has use as a management tool for evaluating watershed N management options.

The Linked Model, when properly calibrated and validated for a given embayment becomes a N management-planning tool as described in the model overview below. The model can assess solutions for the protection or restoration of nutrient-related water quality and allows testing of management scenarios to support cost/benefit evaluations. In addition, once a model is fully functional it can be refined for changes in land-use or embayment characteristics at minimal cost. Also, since the Linked Model uses a holistic approach that incorporates the entire watershed, embayment and tidal source waters, it can be used to evaluate all projects as they relate directly or indirectly to water quality conditions within its geographic boundaries. It should be noted that this approach includes high-order, watershed and sub-watershed scale modeling necessary to develop critical nitrogen targets for each major sub-embayment. The models, data and assumptions used in this process are specifically intended for the purposes stated in the MEP Technical Report, upon which this TMDL is based. As such, the Linked Model process does not contain the type of data or level and scale of analysis necessary to predict the fate and transport of nitrogen through groundwater from specific sources. In addition, any determinations related to direct and immediate hydrologic connection to surface waters are beyond the scope of the MEP's Linked Model process.

The Linked Model provides a quantitative approach for determining an embayment's (1) N sensitivity, (2) N threshold loading levels (TMDL) and (3) response to changes in loading rate. The approach is fully field validated and unlike many approaches, accounts for nutrient sources, attenuation and recycling and variations in tidal hydrodynamics. This methodology integrates a variety of field data and models, specifically:

• Monitoring - multi-year embayment nutrient sampling

• Hydrodynamics
  - Embayment bathymetry (depth contours throughout the embayment)
  - Site-specific tidal record (timing and height of tides)
  - Water velocity records (in complex systems only)
  - Hydrodynamic model

• Watershed Nitrogen Loading
  - Watershed delineation
  - Stream flow (Q) and N load
  - Land-use analysis (GIS)
  - Watershed N model

• Embayment TMDL - Synthesis
  - Linked Watershed-Embayment Nitrogen Model
  - Salinity surveys (for linked model validation)
  - Rate of N recycling within embayment
  - Dissolved oxygen record
  - Macrophyte (eelgrass) survey
  - Infaunal survey (in complex systems)

Application of the Linked Watershed-Embayment Model

The approach developed by the MEP for applying the linked model to specific embayments for the purpose of developing target N loading rates includes:

1) Selecting one or two stations within the embayment system located close to the inland-most reach or reaches which typically have the poorest water quality within the system. These are called "sentinel" stations;

2) Using site-specific information and a minimum of three years of sub-embayment-specific data to select target threshold N concentrations for each sub-embayment. This is done by refining the draft target threshold N concentrations that were developed as the initial step of the MEP process. The target threshold N concentrations that were selected generally occur in higher quality waters near the mouth of the embayment system;

3) Running the calibrated water quality model using different watershed N loading rates to determine the loading rate that will achieve the target threshold N concentration at the sentinel station. Differences between the modeled N load required to achieve the target threshold N concentration and the present watershed N load represent N management goals for restoration and protection of the embayment system as a whole.

Previous sampling and data analyses and the modeling activities described above resulted in four major outputs that were critical to the development of the TMDL. Two outputs are related to **N concentration in the embayment:**

1) The present N concentrations in the sub-embayments
2) Site-specific target threshold N concentrations

And, two outputs are related to **N loadings:**

1) The present N loads to the sub-embayments
2) Load reductions necessary to meet the site specific target threshold N concentrations

In summary: if the water quality standards are met by reducing the N concentration (and thus the N load) at the sentinel station(s), then the water quality goals will be met throughout the entire system. A brief overview of each of the outputs follows:

Nitrogen concentrations in the embayment

1) Observed "present" N concentrations:
Table 3 presents the average concentrations of N measured in this estuarine system from 7 years of data collection by the Coalition for Buzzards Bay and SMAST (2003 - 2009). The overall means and standard deviations of the averages are presented in Appendix B (taken from Table VI-1 of the MEP Technical Report). Water quality sampling stations are shown in Figure 5. The sentinel stations, E-33 and W-12 are noted in red.

Table 3: Present Nitrogen Concentrations and Sentinel Station Target Threshold Nitrogen Concentrations for the Westport River Estuarine System

Westport River Estuary Sub-embayment	Range of Observed Nitrogen Concentration [1] (mg/L)	Target Threshold Nitrogen Concentration (mg/L)[2]
Upper East Branch	0.874-1.102	
Middle East Branch	0.794-0.864	
Lower East Branch (E-33)	0.538-0.700	0.49
Lower West Branch (W-12)	0.449-0.649	0.48
Westport Harbor	0.534	

[1] Average total N concentration from present loading based on an average of the annual N means from 2003- 2009. Ranges of means are provided if the area contained several monitoring stations.
[2] Target threshold N concentrations for the East Branch sentinel station (E-33) and the West Branch sentinel station (W-12).

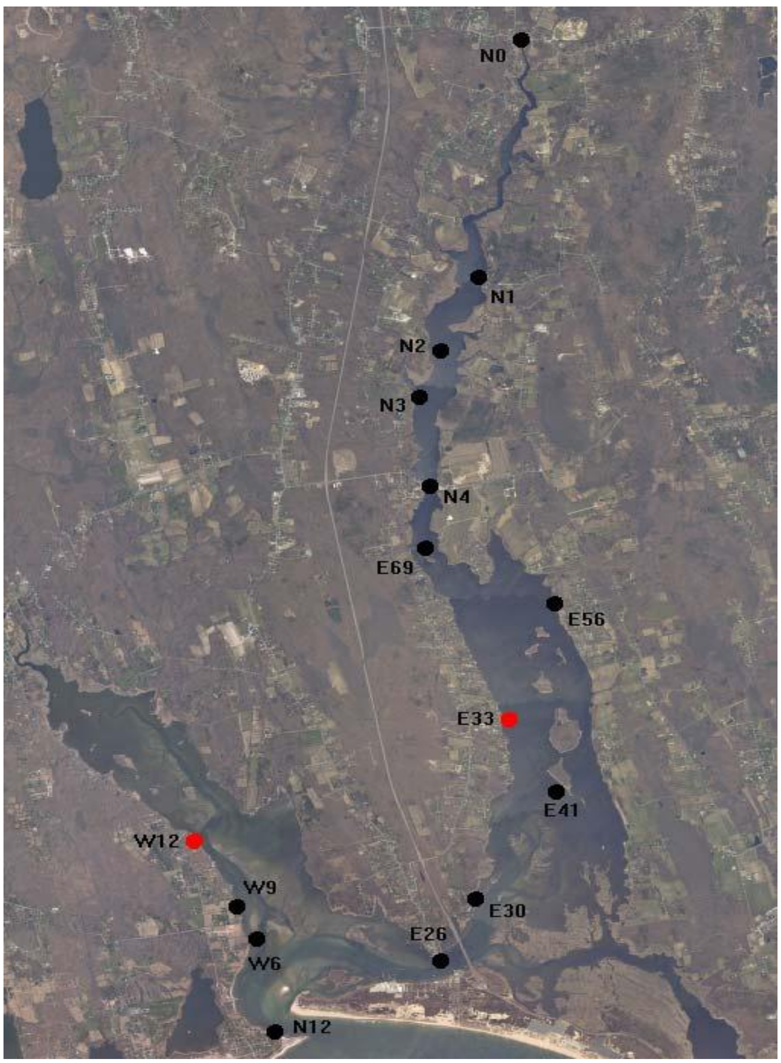


Figure 5: Water Quality Sampling Stations in the Westport River Estuarine System
(Sentinel stations noted in red)

2) Modeled site-specific target threshold N concentrations:
A major component of TMDL development is the determination of the maximum concentrations of N (based on field data) that can occur without causing unacceptable impacts to the aquatic environment. Prior to conducting the analytical and modeling activities described above, SMAST selected appropriate nutrient-related environmental indicators and tested the qualitative and quantitative relationship between those indicators and N concentrations. The Linked Model was then used to determine site-specific target threshold N concentrations by using the specific physical, chemical and biological characteristics of each embayment system.

The target threshold N concentration for an embayment represents the average water column concentration of N that will support the habitat quality and dissolved oxygen concentrations being sought. The water column N level is ultimately controlled by the integration of the watershed N load, the N concentration in the inflowing tidal waters (boundary condition), and dilution and flushing via tidal flows. The water column N concentration is modified by the extent of sediment uptake and/or regeneration and by direct atmospheric deposition.
Target threshold N concentrations in this study were developed to restore or maintain SA and SB waters or high habitat quality. In this system, high habitat quality was defined as stable eelgrass beds extending into the upper and mid regions of the East and West Branches of the Westport River (to documented 1951 coverage) and overall diverse benthic animal communities and dissolved oxygen levels that would support Class SA (West Branch) and SB (East Branch) waters.

The target threshold nitrogen concentrations for the sub-embayments listed in Table 3 were determined as follows:

The approach for determining nitrogen loading rates, which will maintain acceptable habitat quality throughout an embayment system, is to first identify a sentinel location within the embayment and second to determine the nitrogen concentration within the water column which will restore that location to the desired habitat quality. The sentinel location is selected such that the restoration of that one site will necessarily bring the other regions of the system to acceptable habitat quality levels. Once the sentinel site and its target threshold nitrogen concentration are determined, the MEP study modeled nitrogen loads until the targeted nitrogen concentration was achieved.

The determination of the critical nitrogen threshold for maintaining high habitat quality with the Westport River estuarine system is based predominately on temporal trends in eelgrass distribution but also considers the nutrient and oxygen levels, and benthic community indicators. The results from the MEP Study indicate that eelgrass has been lost from the Westport River Estuary in areas that presently support tidally averaged N levels of 0.57 mg/L and >0.50 mg/L in the East and West Branches, respectively. At lower nitrogen levels eelgrass is persisting, but with epiphytes and losses of coverage from the upper and deeper areas of the beds. These sites are associated with N levels of 0.51 mg/L and ~0.50 mg/L in the East and West Branches, respectively, while "healthy" beds are found at lower concentrations, with N levels of <0.428 mg/L and 0.421 mg N/L in the East and West Branches, respectively, and <0.400 mg N/L in Westport Harbor.

It appears that in the Westport River Estuary, the TN level to support high quality eelgrass habitat may be greater than 0.43 mg N/L, but less than 0.50 mg N/L. By comparing N concentrations and physical characteristics of eelgrass areas in this estuary to other estuaries studied by MEP the N threshold was refined to establish a N threshold concentration of 0.49 mg/L at the sentinel station in the East Branch (Station E-33) and 0.48 mg/L at the sentinel station (W-12) in the West Branch.

Actions to restore lost eelgrass habitat will also enhance the health of the existing eelgrass beds within the Westport River estuary resulting in increases in shoot density, reduction in epiphytes and continued low levels of drift algae. Additionally, restoration of this eelgrass habitat will necessarily result in restoration of other resources throughout the Westport River estuarine system. With a reduction in nitrogen loading to the Westport River, benthic infaunal habitat would be restored with an increase in shellfish habitat and shift toward larger, longer lived, deep burrowing organisms.

The findings of the analytical and modeling investigations for this estuarine system are discussed and explained below.

Nitrogen loadings to the embayment

1) Present Loading rates:
In the Westport River Estuarine System overall, the highest N loading from ***controllable*** sources is from agricultural activities (57%) and septic systems (34%). Other sources include, runoff from impervious surfaces (5%), lawn fertilizers (3%) and landfills (1%). The MEP study determined that sediments did not contribute a significant amount of nitrogen to this system. Atmospheric nitrogen deposition to the estuary and watershed surface area was found to be significant (34% of the total load) however this source is considered uncontrollable. (See Figures 4a and 4b)

A subwatershed breakdown of N loading, by source, is presented in Table 4. The data on which Table 4 is based can be found in Table ES-1 and Table IV-2 of the MEP Technical Report.
As previously indicated, the present N loadings to these embayment systems must be reduced in order to restore the impaired conditions and to avoid further nutrient-related adverse environmental impacts. The critical final step in the development of the TMDL is modeling and analysis to determine the loadings required that will achieve the target threshold N concentrations.

2) Nitrogen loads necessary for meeting the site-specific target threshold N concentrations:
Table 5 lists the present watershed N loadings from the Westport River estuarine system and the percent watershed load reductions necessary to achieve the target threshold N concentration at the sentinel stations. This scenario is achieved by reducing the present septic N load in selected subwatersheds as indicated in Table 5. It should be noted that the MEP study found agricultural activities the largest contributor of N to the estuary (57% of the controllable load as compared to 34% from septic systems). The Town of Westport may wish to consider an additional modeling run that investigates a combination of reductions in agricultural loads as well as septic loads.

It is very important to note that load reductions can be produced through a variety of strategies: reduction of any or all sources of N; increasing the natural attenuation of N within the freshwater systems; and/or modifying the tidal flushing through inlet reconfiguration (where appropriate). This scenario establishes the general degree and spatial pattern of reduction that will be required for restoration of the N impaired portions of this system. The Town of Westport, in cooperation with the watershed towns of Dartmouth, Fall River, Freetown, Tiverton RI and Little Compton RI should take any reasonable actions to reduce the controllable N sources.

(report continued next page)

Table 4: Present Nitrogen Loadings to the Westport River Estuarine System

Sub-embayment	Septic System Load (kg N/day)	Agriculture Load (unattenuated) (kg N/day)	Total Attenuated Watershed Load[1] (kg N/day)	Atmospheric Deposition[2] (kg N/day)	Benthic Flux[3] (kg N/day)	Total Nitrogen Load from All Sources[4] (kg N/day)
Old County Road	48.3	62.4	162.6	-	-	162.6
Kirby Brook	7.8	5.5	21.0	-	-	21.0
Snell Creek	4.6	1.0	8.1	-	-	8.1
North East Branch	9.3	84.5	103.1	4.4	-30.4	75.5
South East Branch	15.9	14.6	62.3	20.9	-16.7	63.4
The Let	1.5	1.5	5.8	2.0	11.8	19.5
Angeline Creek	3.1	24.0	34.3	-	-	34.3
Adamsville Brook	17.1	13.5	47.6	-	-	47.6
West Branch	6.5	21.9	32.9	11.2	-6.3	37.8
Westport Harbor	6.6	1.3	10.3	8.2	-30.5	-12.0
System Total	120.5	230.1	488.0	46.6	-72.0	457.8

[1] Includes fertilizer, agriculture, runoff, landfills, atmospheric deposition to lakes and natural surfaces and wastewater from Table ES-1 in the MEP Technical Report , Note the total watershed load is based on yearly loads with the exception of Old County Road which is based on measured summer loads (see Table IV-3, Howes et. al 2013, pg. 63)

[2] Atmospheric deposition to the estuarine surface only

[3] Nitrogen loading from sediments

[4] Composed of fertilizer, agriculture, runoff, landfills, wastewater, atmospheric deposition and benthic nitrogen input

Table 5: Present Watershed Nitrogen Loading Rates, Calculated Loading Rates that are Necessary to Achieve Target Threshold Nitrogen Concentrations, and the Percent Reductions of the Existing Loads Necessary to Achieve the Target Threshold Loadings

Sub-embayment System	Present Watershed Load[1] (kg N/day)	Target Threshold Watershed Load[2] (kg N/day)	Percent Watershed Load Reductions Needed to Achieve Target
Old County Road	162.6	111.8	-31.2%
Kirby Brook	21.0	13.2	-37.2%
Snell Creek	8.1	3.6	-56.0%
North East Branch	103.1	93.0	-9.8%
South East Branch	62.3	46.5	-25.4%
The Let	5.8	5.8	0.0
Angeline Creek	34.3	34.3	0.0
Adamsville Brook	47.6	47.6	0.0
West Branch	32.9	32.9	0.0
Westport Harbor	10.3	10.3	0.0
System Total	488.0	398.9	-18.3%

[1]Includes fertilizer, agriculture, runoff, landfills, atmospheric deposition to lakes and natural surfaces and wastewater

[2] Target threshold watershed load is the N load from the watershed (including natural background) needed to meet the target threshold N concentrations identified in Table 3, above. Taken from Tables ES-2 and VIII-3 in the MEP Technical Report

Total Maximum Daily Loads

As described in EPA guidance, a total maximum daily load (TMDL) identifies the loading capacity of a water body for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a water body can receive without violating water quality standards. The TMDLs are established to protect and/or restore the estuarine ecosystem, including eelgrass, the leading indicator of ecological health, thus meeting water quality goals for aquatic life support. Because there are no "numerical" water quality standards for N, the TMDLs for the Westport River estuarine system are aimed at establishing the loads that would correspond to specific N concentrations determined to be protective of the water quality and ecosystems.

The development of a TMDL requires detailed analyses and mathematical modeling of land use, nutrient loads, water quality indicators, and hydrodynamic variables (including residence time) for each waterbody system. The results of the mathematical model are correlated with estimates of impacts on water quality, including negative impacts on eelgrass (the primary indicator), as well as dissolved oxygen, chlorophyll *a* and benthic infauna.

The TMDL can be defined by the equation:

$$TMDL = BG + WLAs + LAs + MOS$$

Where:
TMDL = Total Maximum Daily Load is the loading capacity of receiving water
BG = natural background
WLAs = Waste Load allocation is the portion allotted to point sources
LAs = Load Allocation is the portion allotted to (cultural) non-point sources
MOS = margin of safety

Background Loading

Natural background N loading is included in the loading estimates, but is not quantified or presented separately. Background loading was calculated on the assumption that the entire watershed is forested with no anthropogenic sources of N. It is accounted for in this TMDL but not defined as a separate component. Readers are referred to Table ES-1 of the MEP Technical Report for estimated loading due to natural conditions.

Waste Load Allocations

Waste load allocations (WLA) identify the portion of the loading capacity allocated to existing and future point sources of wastewater. In the Westport River estuary system there are no NPDES regulated point source surface water discharges in the watershed with the exception of certain stormwater discharges. EPA interprets 40 CFR 130.2(h) to require that allocations for NPDES regulated discharges of stormwater be included in the waste load component of the TMDL.

Some areas of the watershed in the towns of Westport, Dartmouth and Tiverton (RI) contain EPA designated "urbanized areas" and as such are required to obtain coverage under the NPDES Phase II General Permit for stormwater discharges from Small Municipal Separate Storm Sewer Systems (MS4s). In addition, there are directly connected impervious areas (DCIAs) throughout the entire watershed as identified by the EPA (http://www.epa.gov/region1/npdes/stormwater/ma.html) which discharge stormwater directly to waterbodies via a conveyance system such as a swale, pipe or ditch. To develop a more conservative estimate of the waste load allocation from stormwater, MassDEP has determined that stormwater discharge from all DCIAs (including those in non-regulated areas as well as urbanized regulated areas) shall be treated as part of a waste load allocation. Since there are no other point sources of nitrogen in the Westport River watershed the DCIA stormwater load is the total waste load allocation for the TMDL.

The Linked Model accounts for stormwater and groundwater loadings in one aggregate allocation as a non-point source – combining the assessments of waste water and stormwater (including stormwater that infiltrates into the soil and direct discharge pipes into water bodies) for the purpose of developing control strategies. Based on land use, the Linked Model accounts for loading from stormwater, but does not differentiate stormwater into a load and waste load allocation. In order to distinguish the point source or waste load allocation of stormwater originating from DCIAs from the nonpoint source stormwater contribution (load allocation), the percent DCIA for each landuse type in the each subembayment watershed was determined using EPA methodology (EPA 2010). In order to determine the wasteload allocation, the total DCIA area for each subembayment was divided by the total impervious area in each subembayment watershed and then multiplied by the total impervious surface N load as determined by the MEP Technical report (in kg N/day).

The waste load allocation from stormwater has been calculated using the EPA (2010) methodology for each MEP subembayment watershed using a GIS system. The Westport River watershed DCIA area accounts for approximately 3% of the total watershed area (total DCIA area / total watershed area). Almost all (99%) of the DCIA area resides within Massachusetts. Approximately 1% of the DCIA area lies within the Rhode Island towns of Tiverton and Little Compton (Total DCIA in RI/total DCIA area).

For the Westport River embayment system this calculated stormwater waste load based on the DCIA method is approximately 1.5% of the total N load or 8.6 kg N/day as compared to the overall attenuated watershed N load of 583 kg N/day. (Howes et. al, 2013, Table IV-2). This conservative load is a negligible amount of the total nitrogen load to the embayment when compared to other sources. (See Appendix C for WLA calculations and additional information about the stormwater loading determination.)

Load Allocations

Load allocations identify the portion of loading capacity allocated to existing and future nonpoint sources. In the case of the Westport River estuary system most of the locally controllable nonpoint source loadings are from agricultural activities and on-site subsurface wastewater disposal systems (septic systems). Other contributing land uses include the landfills, lawn fertilizers and stormwater runoff (except stormwater originating from DCIA which is discussed above as part of the waste load).

Figure 4b (above) and Figure 6 (below) illustrate that agriculture is the most significant source of the controllable N load (230.1 kg N/day), with septic system contribution second (120.48 kg N/day). Lawn fertilizers, runoff and the landfills combined contribute 36.6 kg N/day (from Table IV-2 in the MEP Technical Report). In addition, there are nonpoint sources of N from sediments, natural background and atmospheric deposition that are not feasibly controllable and thus are not shown here.

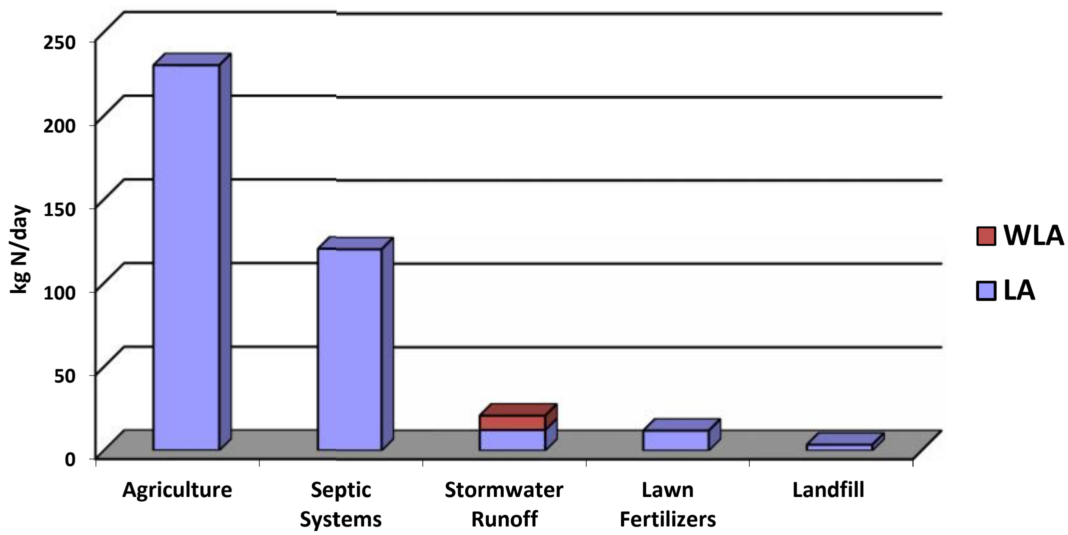


Figure 6: Westport River Estuarine System Locally Controllable N Sources

Figure 6 also illustrates the WLA for stormwater (8.6 kg N/day) contributes approximately 41% of the total load from stormwater runoff. As described above, stormwater runoff from DCIA (directly connected impervious area) was considered a part of the waste load allocation, rather than the load allocation. Stormwater runoff from other areas is considered a component of the nonpoint source load allocation. Therefore, the TMDL accounts for stormwater from directly connected impervious areas as a point source and stormwater runoff from other areas and from groundwater as a non-point source, thus separating the assessments of wastewater and stormwater for the purpose of developing control strategies.

In general, benthic N flux is a function of N loading and particulate organic N (PON). Projected benthic fluxes are based upon projected PON concentrations and watershed N loads and are calculated by multiplying the present N flux by the ratio of projected PON to present PON using the following formulae:

Projected N flux = (present N flux) (PON projected / PON present)

When: $PON\ projected = (R_{load})\ (D_{PON})\ + PON_{present\ offshore}$

When: R_{load} = *(projected N load) / (Present N load)*

And: D_{PON} is the PON concentration above background determined by:

$$D_{PON} = (PON_{present\ embayment} - PON_{present\ offshore})$$

Typically, the projected benthic fluxes are lower than the existing benthic input because projected reductions of N loadings from the watershed will result in reductions of nutrient concentrations in the sediments and therefore, over time, reductions in loadings from the sediments will occur.

In the Westport River system the MEP study reported negative benthic flux loads for most of the sub-embayments (Table 4, above). Negative benthic flux was incorporated into the water quality model to determine the watershed N load and the necessary watershed load reductions, however MassDEP has determined that negative loads are not appropriate for incorporating into the TMDL. The TMDL by definition is for regulation of loading inputs and, as such, a negative number for a load does not apply. Accordingly, negative benthic flux loads were set to zero for determination of the TMDL.

The loadings from atmospheric sources incorporated into the TMDL are the same rates presently occurring because, as discussed above, local control of atmospheric loadings is not considered feasible.

Margin of Safety

Statutes and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality [CWA para 303 (d)(20©, 40C.G.R. para 130.7©(1)]. The MOS must be designed to ensure that any uncertainties in the data or calculations used to link pollutant sources to water quality impairment modeling will be accounted for in the TMDL and ensure protection of the beneficial uses. The EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. An explicit MOS quantifies an allocation amount separate from other Load and Wasteload Allocations. An explicit MOS can incorporate reserve capacity for future unknowns, such as population growth or effects of climate change on water quality. An implicit MOS is not specifically quantified but consists of statements of the conservative assumptions used in the analysis. The MOS for the Westport River estuarine system TMDLs is implicit. MassDEP used conservative assumptions to develop numeric model applications that account for the MOS. These assumptions are described below, and they account for all sources of uncertainty, including the potential impacts of changes in climate.

While the general vulnerabilities of coastal areas to climate change can be identified, specific impacts and effects of changing estuarine conditions are not well known at this time (http://www.mass.gov/eea/waste-mgnt-recycling/air-quality/green-house-gas-and-climate-change/climate-change-adaptation/climate-change-adaptation-report.html). Because the science is not yet available, MassDEP is unable to analyze climate change impacts on streamflow, precipitation, and nutrient loading with any degree of certainty for TMDL development. In light of these uncertainties and informational gaps, MassDEP has opted to address all sources of uncertainty through an implicit MOS. MassDEP does not believe that an explicit MOS approach is appropriate under the circumstances or will provide a more protective or accurate MOS than the implicit MOS approach, as the available data simply does not lend itself to characterizing and estimating loadings to derive numeric allocations within confidence limits. Although the implicit MOS approach does not expressly set aside a specific portion of the load to account for potential impacts of climate change, MassDEP has no basis to conclude that the conservative assumptions that were used to develop the numeric model applications are insufficient to account for the lack of knowledge regarding climate change.

Conservative assumptions that support an implicit MOS:

1. Use of conservative data in the linked model

The watershed N model provides conservative estimates of N loads to the embayment. Nitrogen transfer through direct groundwater discharge to estuarine waters is based upon studies indicating negligible aquifer attenuation and dilution, i.e. 100% of load enters embayment. This is a conservative estimate of loading because studies have also shown that in some areas less than 100% of the load enters the estuary. In this context, “direct groundwater discharge” refers to the portion of fresh water that enters an estuary as groundwater seepage into the estuary itself, as opposed to the portion of fresh water that enters as surface water inflow from streams, which receive much of their water from groundwater flow. Nitrogen from the upper watershed regions, which travels through ponds or wetlands, almost always enters the embayment via stream flow, and was directly measured (over 12-16 months) to determine attenuation.

The hydrodynamic and water quality models have been assessed directly. In the many instances where the hydrodynamic model predictions of volumetric exchange (flushing) have also been directly measured by field measurements of instantaneous discharge, the agreement between modeled and observed values has been >95%. Since the water quality model incorporates all of the outputs from the other models, this excellent fit indicates a high degree of certainty in the final result. The high level of accuracy of the model provides a high degree of confidence in the output; therefore, less of a margin of safety is required.

Similarly, the water column N validation dataset was also conservative. The model is validated to measured water column N. However, the model predicts average summer N concentrations. The very high or low measurements are marked as outliers. The effect is to make the N threshold more accurate and scientifically defensible. If a single measurement two times higher than the next highest data point in the series raises the average 0.05 mg N/L, this would allow for a higher “acceptable” load to the embayment. Marking the very high outlier is a way of preventing a single and rare bloom event from changing the N threshold for a system. This effectively strengthens the data set so that a higher margin of safety is not required.

Finally, the predicted reductions in benthic regeneration of N are most likely underestimates, i.e. conservative. The reduction is based solely on a reduced deposition of PON, due to lower primary production rates under the reduced N loading in these systems. As the N loading decreases and organic inputs are reduced, it is likely that rates of coupled remineralization-nitrification, denitrification and sediment oxidation will increase. Benthic regeneration of N is dependent upon the amount of PON deposited to the sediments and the percentage that is regenerated to the water column versus being denitrified or buried. The regeneration rate projected under reduced N loading conditions was based upon two assumptions (1) PON in the embayment in excess of that of inflowing tidal water (boundary condition) results from production supported by watershed N inputs and (2) Presently enhanced production will decrease in proportion to the reduction in the sum of watershed N inputs and direct atmospheric N input. The latter condition would result in equal embayment versus boundary condition production and PON levels if watershed N loading and direct atmospheric deposition could be reduced to zero (an impossibility of course). This proportional reduction assumes that the proportion of remineralized N will be the same as under present conditions, which is almost certainly an underestimate. As a result, future N regeneration rates are overestimated which adds to the margin of safety.

2. Conservative sentinel station/target threshold nitrogen concentration

Conservatism was used in the selection of the sentinel stations and target threshold N concentrations. The sites were chosen that had stable eelgrass or benthic animal (infaunal) communities, and not those just starting to show impairment, which would have slightly higher N concentration. Meeting the target threshold N concentrations at the sentinel stations will result in reductions of N concentrations in the rest of the system.

3. Conservative approach

The target loads were based on tidally averaged N concentrations on the outgoing tide, which is the worst case condition because that is when the N concentrations are the highest. The N concentrations will be lower on the flood tides and therefore this approach is conservative.

In addition to the margin of safety within the context of setting the N threshold levels as described above, a programmatic margin of safety also derives from continued monitoring of these embayments to support adaptive management. This continuous monitoring effort provides the ongoing data to evaluate the improvements that occur over the multi-year implementation of the N management plan. This will allow refinements to the plan to ensure that the desired level of restoration is achieved.

Seasonal Variation

Since the TMDLs for the waterbody segments are based on the most critical time period, i.e. the summer growing season, the TMDLs are protective for all seasons. The daily loads can be converted to annual loads by multiplying by 365 (the number of days in a year). Nutrient loads to the embayment are based on annual loads for two reasons. The first is that primary production in coastal waters can peak in both the late winter-early spring and in the late summer-early fall periods. Second, as a practical matter, the types of controls necessary to control the N load, the nutrient of primary concern, by their very nature do not lend themselves to intra-annual manipulation since the majority of the N is from non-point sources. Thus, the annual loads make sense since it is difficult to control non-point sources of N on a seasonal basis and N sources can take considerable time to migrate to impacted waters.

TMDL Values for the Westport River Estuarine System

As outlined above, the total maximum daily loadings of N that would provide for the restoration andprotection of the embayment were calculated by considering all sources of N grouped by natural background, point sources and non-point sources. A more meaningful way of presenting the loadings data from an implementation perspective is presented in Table 6.

Table 6: The Total Maximum Daily Loads (TMDL) for the Westport River Estuarine System

Sub-embayment System	Target Threshold Watershed Load[1] (kg N/day)	Atmospheric Deposition (kg N/day)	Nitrogen Load from Sediments[2] (kg N/day)	TMDL[3] (kg N/day)
Old County Road	111.82	-	-	111.82
Kirby Brook	13.17	-	-	13.17
Snell Creek	3.58	-	-	3.58
North East Branch	93.03	4.36	0	97.39
South East Branch	46.48	20.92	0	67.4
The Let	5.76	1.97	11.81	19.54
Angeline Creek	34.3	-	-	34.3
Adamsville Brook	47.62	-	-	47.62
West Branch	32.9	11.15	0	44.05
Westport Harbor	10.25	8.23	0	18.48
System Total	398.9	46.63	11.81	457.34

[1] Target threshold watershed load (including natural background) is the load from the watershed needed to meet the embayment target threshold nitrogen concentration identified in Table 3.
[2] Projected sediment N loadings obtained by reducing the present benthic flux loading rates (Table 4) proportional to proposed watershed load reductions and factoring in the existing and projected future concentrations of PON. (Negative fluxes set to zero.)
[3] Sum of target threshold watershed load, sediment load and atmospheric deposition load.

In this table the N loadings from the atmosphere and sediments are listed separately from the target watershed threshold loads which are composed of natural background N along with locally controllable N from agriculture, on-site subsurface wastewater disposal systems, landfills, stormwater runoff and lawn fertilizer sources. In the case of the Westport River system the TMDLs were calculated by projecting 100% reductions in the septic system load from the North East Branch, South East Branch, Old County Road, Kirby Brook and Snell Creek subwatersheds. Once again the goals of these TMDLs are to achieve the identified target threshold N concentration at the identified sentinel stations. The target loads identified in this table represents one alternative-loading scenario to achieve that goal but other scenarios may be possible and approvable as well.

Implementation Plans

The critical element of this TMDL process is achieving the sentinel station specific target threshold N concentrations presented in Table 3 above that are necessary for the restoration and protection of water quality and eelgrass habitat within the Westport River estuarine system. In order to achieve these target threshold N concentrations, N loading rates must be reduced throughout the system. Table 6 lists the target watershed threshold loads for this embayment. If this threshold load is achieved, this embayment will be protected.

Septic Systems:
Wastewater loading to the Westport River Estuarine System consists entirely of loading from septic systems as there are no MassDEP groundwater discharge permits (GWDPs) or wastewater treatment plants that discharge within the modeled watershed. As previously noted, there is a variety of loading reduction scenarios that could achieve the target threshold N concentrations. Local officials can explore other loading reduction scenarios through additional modeling as part of their Comprehensive Wastewater Management Plan (CWMP). It must be demonstrated however, that any alternative implementation strategies will be protective of the entire embayment system. To this end, additional linked model runs can be performed by the MEP at a nominal cost to assist the planning efforts of the town in achieving target N loads that will result in the desired target threshold N concentration.

The CWMP should include a schedule of the selected strategies and estimated timelines for achieving those targets. However, the MassDEP realizes that an adaptive management approach may be used to observe implementation results over time and allow for adjustments based on those results. Because a large part of the controllable N load is from septic systems for private residences the CWMP should assess the most cost-effective options for achieving the target N watershed loads, including but not limited to, sewering and treatment for N control of sewage and septage at either centralized or de-centralized locations and denitrifying systems for all private residences. Table 5 (above) illustrates a scenario to achieve the target threshold N concentration by reducing the present septic N load in selected subwatersheds.

If a community chooses to implement TMDL measures without a CWMP it must demonstrate that these measures will achieve the target threshold N concentration. (Note: Communities that choose to proceed without a CWMP will not be eligible for State Revolving Fund 0% loans.)

Table 7: Summary of the Present On-Site Subsurface Wastewater Disposal System Loads, and the Loading Reductions Necessary to Achieve the TMDL by Reducing On-Site Subsurface Wastewater Disposal System Loads Only

Westport River System/Subwatershed	Present Septic System Load (kg N/day)	Threshold Septic System Load (kg N/day)	Threshold Septic System Load % Change
North East Branch	9.3	0.00	-100.0%
West Branch	6.54	6.54	0.0%
South East Branch	15.86	0.00	-100.0%
The Let	1.45	1.45	0.0%
Westport Harbor	6.59	6.59	0.0%
Old County Road	48.26	0.00	-100.0%
Kirby Brook	7.79	0.00	-100.0%
Adamsville Brook	17.07	17.07	0.0%
Angeline Brook	3.08	3.08	0.0%
Snell Creek	4.56	0.0	-100.0%
System Total	120.48	34.72	-71.2%

Agriculture:

MassDEP is aware that the Westport Town Agricultural Committee believes that the overall contribution of TN from the agricultural community is less than the estimates identified in the MEP report. Even if this is the case however it is clear that agriculture is still a major contributor of N load to this system and MassDEP believes it is reasonable to try to reduce the agricultural contribution through the implementation of feasible agricultural best management practices (BMPs) with a goal of reducing N contribution from agricultural sources by 10% watershed-wide. The watershed communities should request an additional model run from SMAST that considers a scenario that includes recommendations for reductions in agriculture N loads as well as a sensitivity analysis to determine the potential benefits of agricultural reductions as well as septic loads from the various sub-embayments. This will help focus agricultural BMP implementation activities to areas that will most effectively reduce N loads and perhaps reduce the need for sewering. For example, based on the MEP report, the percentage contribution of agriculture N load from the subwatersheds of the North East Branch, West Branch, Old County Road and Angeline Creek ranged from 38% to as much as 81% of the watershed N load. The MEP Technical report TMDL scenario recommends 100% removal of the septic load from North East Branch and Old County Road subwatersheds. However, by reducing agriculture N loads from these subwatersheds, even by just 10%, the need for 100% reduction of septic load could be significantly diminished.

The watershed towns of Westport, Dartmouth, Fall River, Freetown, Tiverton, and Little Compton are urged to meet the target threshold N concentrations by reducing N loadings from any and all sources, through whatever means are available and practical, including reductions in stormwater runoff and/or fertilizer use within the watershed through the establishment of local by-laws and/or the implementation of agricultural and stormwater BMPs in addition to reductions in on-site subsurface wastewater disposal system loadings.

Based on land-use and the fact that the watershed of this system is located within a number of communities it follows that nitrogen management necessary for the restoration of the Westport River estuarine system may be formulated and implemented through cooperative efforts among the watershed towns.

Landfill:
The MEP project (Howes *et. al*, 2013) developed nitrogen loads for three landfills. Two landfills were located in the Old County Road watershed: Jarabeck Farm and Crapo Landfill. Jarabeck Farm, an unlined landfill, is capped and closed but not required to conduct nitrate monitoring (McLaughlin, 2015). The Crapo Hill Landfill, a lined landfill, is currently in use. The Westport Landfill located in the North East Branch watershed is an unlined landfill that is capped/closed (McLaughlin, 2015). The cap for this landfill was built in 1999 and the landfill is in its post closure monitoring period. It is expected that these landfill nitrogen loads will likely be eliminated and therefore these TMDLs are calculated based on that assumption.

Stormwater:
Dartmouth and Westport are one of the 237 communities in Massachusetts covered by the Phase II stormwater program requirements. Portions of the Westport River watershed in these towns lie within their regulated area. Tiverton RI also has Phase II regulated area within the watershed.

Municipalities regulated under this Phase II program must develop and implement a storm water management plan (SWMP) for their regulated municipal separate storm sewer systems (MS4s) which must employ, and set measurable goals for the following six minimum control measures:

- public education and outreach particularly on the proper disposal of pet waste,
- public participation/involvement,
- illicit discharge detection and elimination,
- construction site runoff control,
- post construction runoff control, and
- pollution prevention/good housekeeping.

The NPDES permits which EPA has issued in Massachusetts to implement the Phase II Stormwater program do not establish numeric effluent limitations for stormwater discharges. Rather, they establish narrative requirements, including best management practices, to meet the six minimum control measures and to meet State Water Quality Standards. Portions of some of the municipalities in the watershed are not currently regulated under the Phase II program. It is recommended that those municipalities consider expanding some or all of the six minimum control measures and other BMPs throughout their jurisdiction in order to minimize storm water contamination.

The majority of the WLA is due to stormwater in the Old County Rd watershed (See Appendix C and as defined by Howes et. al, 2013). This watershed area includes contributing areas from the towns of Dartmouth, Freetown, Fall River and Westport. According to their most recent (2014) NPDES Phase II MS4 Annual Report, the town of Dartmouth is continuing work on storm drain mapping and has retained the services of a consultant to help with this endeavor (Dartmouth 2014). In addition, the Town conducts an ongoing public outreach campaign that includes fact sheets, stormwater informational brochures, storm drain stenciling and a cigarette litter prevention program. The town of Dartmouth provides training to DPW staff on pollution prevention and good housekeeping and has taken steps to reduce the amount of sand applied during winter snow operations.

According to their most recent (2014) NPDES Phase II MS4 Annual Report, the City of Fall River updates their GIS stormwater map annually, conducts dry weather outfall screening and investigates stormwater infrastructure (Fall River 2014). The City of Fall River has conducted an annual shoreline cleanup day as well as educational activities with a local school. In addition, the city conducts an ongoing public outreach campaign that includes website, posters, handouts, mailers, flyers and signage with information on various pollution prevention activities and regulations. The city trains staff on pollution prevention and good housekeeping and conducts street sweeping and other activities to reduce the amount of solids discharged to local waterways.

The town of Freetown conducts a number of activities as part of their NPDES Phase II MS4 requirements (Freetown 2014). The town has conducted an ongoing public outreach campaign that includes website, posters, handouts, and flyers with information on stormwater issues. The town has also used the local public access channel to post stormwater information. The town has mapped its stormwater infrastructure and has directed its pollution prevention management towards preventing illegal dumping and remediating failed septic tanks. Freetown's pollution prevention program consists among other things of catch basin cleaning.

The town of Westport conducts a number of activities as part of their NPDES Phase II MS4 requirements (Westport 2013). The town has conducted a number of outreach activities including waterbody signage, curriculum development for local schools, information flyers and public outreach associated with 319 BMPs as well as public involvement in shoreline cleanups, storm drain stenciling and loans to repair to local septic systems. In addition the town has conducted bacteria source tracking and indicated a willingness to support MassDEP bacteria source tracking in the watershed (personal communication, Jennifer Sheppard, SERO, MassDEP). The town also conducts staff training, street sweeping, catch basin cleaning and other activities as part of its pollution prevention and good housekeeping operations.

Climate Change:

MassDEP recognizes that long-term (25+ years) climate change impacts to southeastern Massachusetts, including the area of this TMDL, are possible based on known science. Massachusetts Executive Office of Energy and Environmental Affairs 2011Climate Change Adaptation Report: http://www.mass.gov/eea/waste-mgnt-recycling/air-quality/climate-change-adaptation/climate-change-adaptation-report.html predicts that by 2100 the sea level could be from 1 to 6 feet higher than the current position and precipitation rates in the Northeast could increase by as much as 20 percent. However, the details of how climate change will affect sea level rise, precipitation, streamflow, sediment and nutrient loading in specific locations are generally unknown. The ongoing debate is not about whether climate change will occur, but the rate at and the extent to which it will occur and the adjustments needed to address its impacts. EPA's 2012 Climate Change Strategy http://water.epa.gov/scitech/climatechange/upload/epa_2012_climate_water_strategy_full_report_final.pdf states: "Despite increasing understanding of climate change, there still remain questions about the scope and timing of climate change impacts, especially at the local scale where most water-related decisions are made." For estuarine TMDLs in southeastern Massachusetts, MassDEP recognizes that this is particularly true, where water quality management decisions and implementation actions are generally made and conducted at the municipal level on a sub-watershed scale.

EPA's Climate Change Strategy identifies the types of research needed to support the goals and strategic actions to respond to climate change. EPA acknowledges that data are missing or not available for making water resource management decisions under changing climate conditions. In addition, EPA recognizes the limitation of current modeling in predicting the pace and magnitude of localized climate change impacts and recommends further exploration of the use of tools, such as atmospheric, precipitation and climate change models, to help states evaluate pollutant load impacts under a range of projected climatic shifts.

In 2013, EPA released a study entitled, "Watershed modeling to assess the sensitivity of streamflow, nutrient, and sediment loads to potential climate change and urban development in 20 U.S. watersheds." (National Center for Environmental Assessment, Washington D.C.; EPA/600/R-12/058F). The closest watershed to southeastern Massachusetts that was examined in this study is a New England coastal basin located between Southern Maine and Central Coastal Massachusetts. These watersheds do not encompass any of the watersheds in the Massachusetts Estuary Project (MEP) region, and it has vastly different watershed characteristics, including soils, geography, hydrology and land use – key components used in a modeling analysis. The initial "first order" conclusion of this study is that, in many locations, future conditions, including water quality, are likely to be different from past experience. However, most significantly, this study did not demonstrate that changes to TMDLs (the water quality restoration targets) would be necessary for the region. EPA's 2012 Climate Change Strategy also acknowledges that the Northeast, including New England, needs to develop standardized regional assumptions regarding future climate change impacts. EPA's 2013 modeling study does not provide the scientific methods and robust datasets needed to predict specific long-term climate change impacts in the MEP region to inform TMDL development.

MassDEP believes that impacts of climate change should be addressed through TMDL implementation with an adaptive management approach in mind. Adjustments can be made as environmental conditions, pollutant sources, or other factors change over time. Massachusetts Coastal Zone Management (CZM) has developed a StormSmart Coasts Program (2008) to help coastal communities address impacts and effects of erosion, storm surge and flooding which are increasing due to climate change. The program, www.mass.gov/czm/stormsmart offers technical information, planning strategies, legal and regulatory tools to communities to adapt to climate change impacts.

As more information and tools become available, there may be opportunities to make adjustments in TMDLs in the future to address predictable climate change impacts. When the science can support assumptions about the effects of climate change on the nitrogen loadings to the Westport River Estuarine System the TMDL can be reopened, if warranted.
In summary the watershed towns are urged to meet the target threshold N concentrations by reducing N loadings from any and all sources, through whatever means are available and practical, including reductions in N contributions from agriculture, storm-water runoff and/or fertilizer use within the watershed through the establishment of local by-laws and/or the implementation of storm-water and agricultural BMPs in addition to reductions in on-site subsurface wastewater disposal system loadings.

MassDEP's MEP Implementation Guidance report: http://www.mass.gov/eea/agencies/massdep/water/watersheds/coastal-resources-and-estuaries.html provides N loading reduction strategies that are available to the towns of Westport, Dartmouth, Freetown, and the city of Fall River, MA, as well as, the towns of Tiverton and Little Compton, RI and could be incorporated into the implementation plans. The following topics related to N reduction are discussed in the Guidance:

- Wastewater Treatment
    - On-Site Treatment and Disposal Systems
    - Cluster Systems with Enhanced Treatment
    - Community Treatment Plants
    - Municipal Treatment Plants and Sewers
- Tidal Flushing
    - Channel Dredging
    - Inlet Alteration
    - Culvert Design and Improvements
- Storm-water Control and Treatment *
    - Source Control and Pollution Prevention
    - Storm-water Treatment
- Attenuation via Wetlands and Ponds
- Water Conservation and Water Reuse
- Management Districts
- Land Use Planning and Controls
    - Smart Growth
    - Open Space Acquisition
    - Zoning and Related Tools
- Nutrient Trading

* All Massachusetts town and cities included in this TMDL are currently covered by the Phase II storm water program requirements.

Monitoring Plan

MassDEP believes that there are two forms of monitoring that are useful to determine progress towards achieving compliance with the TMDL. MassDEP's position is that TMDL implementation will be conducted through an iterative process where adjustments maybe needed in the future. The two forms of monitoring include 1) tracking implementation progress as approved in the CWMP plan and 2) monitoring water quality and habitat conditions in the estuaries, including but not limited to, the sentinel stations identified in the MEP Technical Report.

The CWMP will evaluate various options to achieve the goals set out in the TMDL report and the MEP Technical Report. It will also make a final recommendation based on existing or additional modeling runs, set out required activities, and identify a schedule to achieve the most cost effective solution that will result in compliance with the TMDL. Once approved by the Department, tracking progress on the agreed upon plan will, in effect, also be tracking progress towards water quality improvements in conformance with the TMDL.

Relative to water quality MassDEP believes that an ambient monitoring program much reduced from the data collection activities needed to properly assess conditions and to populate the model, will be important to determine actual compliance with water quality standards. Although the TMDL values are not fixed, the target threshold N concentrations at the sentinel stations are fixed. Through discussions amongst the MEP it is generally agreed that existing monitoring programs which were designed to thoroughly assess conditions and populate water quality models can be substantially reduced for compliance monitoring purposes. Although more specific details need to be developed on a case-by-case basis MassDEP believes that about half the current effort (using the same data collection procedures) would be sufficient to monitor compliance over time and to observe trends in water quality changes. In addition, the benthic habitat and communities would require periodic monitoring on a frequency of about every 3-5 years. Finally, in addition to the above, existing monitoring conducted by MassDEP for eelgrass should continue into the future to observe any changes that may occur to eelgrass populations as a result of restoration efforts.

The MEP will continue working with the watershed communities to develop and refine monitoring plans that remain consistent with the goals of the TMDL. Through the adaptive management approach ongoing monitoring will be conducted and will indicate if water quality standards are being met. If this does not occur other management activities would have to be identified and considered to reach to goals outlined in this TMDL. It must be recognized however that development and implementation of a monitoring plan will take some time, but it is more important at this point to focus efforts on reducing existing watershed loads to achieve water quality goals.

Reasonable Assurances

MassDEP possesses the statutory and regulatory authority, under the water quality standards and/or the State Clean Water Act (CWA), to implement and enforce the provisions of the TMDL through its many permitting programs including requirements for N loading reductions from on-site subsurface wastewater disposal systems. However, because most non-point source controls are voluntary, reasonable assurance is based on the commitment of the locality involved. Dartmouth and Westport have demonstrated this commitment through the comprehensive wastewater planning that they initiated well before the generation of the TMDL. The towns expect to use the information in this TMDL to generate support from their citizens to take the necessary steps to remedy existing problems related to N loading from on-site subsurface wastewater disposal systems, agriculture, stormwater runoff (including lawn fertilizers), and to prevent any future degradation of these valuable resources. As the towns implement these TMDLs the loading values (kg/day of N) will be used by MassDEP for guidance for permitting activities and should be used by the community as a management tool.

In addition, reasonable assurances that the TMDL will be implemented include enforcement of regulations, availability of financial incentives and local, state and federal programs for pollution control. EPA's Stormwater NPDES permit coverage will address discharges from municipally owned stormwater drainage systems. Enforcement of regulations controlling non-point discharges include local implementation of the Commonwealth's Wetlands Protection Act and Rivers Protection Act, Title 5 regulations for on-site subsurface wastewater disposal systems and other local regulations (such as the Town of Rehoboth's stable regulations).

Financial incentives include MassDEP's non-point source control grant program to address non-point source pollution sources statewide. The Department has developed a Nonpoint Source Management Plan that sets forth an integrated strategy and identifies important programs to prevent, control, and reduce pollution from nonpoint sources and more importantly to protect and restore the quality of waters in the Commonwealth. The Clean Water Act, Section 319, specifies the contents of the management plan. The plan is an implementation strategy for BMPs with attention given to funding sources and schedules.

Statewide implementation of the Management Plan is being accomplished through a wide variety of federal, state, local, and non-profit programs and partnerships. It includes partnering with the Massachusetts Coastal Zone Management on the implementation of Section 6217 program. That program outlines both short and long term strategies to address urban areas and stormwater, marinas and recreational boating, agriculture, forestry, hydro modification, and wetland restoration and assessment. The CZM 6217 program also addresses TMDLs and nitrogen sensitive embayments and is crafted to reduce water quality impairments and restore segments not meeting state standards.

In addition, the state is partnering with the Natural Resource Conservation Service (NRCS) to provide implementation incentives through the National Farm Bill. As a result of this effort, NRCS now prioritizes its Environmental Quality Incentive Program (EQIP) funds based on MassDEP's list of impaired waters. Over the last several years EQIP funds have been used throughout the Commonwealth to address water quality goals through the application of structural and non-structural BMPs.

MassDEP, in conjunction with US-EPA, also provides a grant program to implement nonpoint source BMPs that address water quality goals. The section 319 funding provided by US-EPA is used to apply needed implementation measures and provide high priority points for projects that are designed to address 303d listed waters and to implement TMDLs. Additional information related to the non-point source program, including the Management Plan that contains a complete list of funding sources for implementation of nonpoint source pollution can be found at: http://mass.gov/dep/water/resources/nonpoint.htm#plan.

The State Revolving Fund (SRF) Program provides low interest loans to eligible applicants for the abatement of water pollution problems across the Commonwealth. Since July 2002 the MassDEP has issued millions of dollars for the planning and construction of combined sewer overflow (CSO) facilities and to address stormwater pollution. Loans have been distributed to municipal governments statewide to upgrade and replace failed Title 5 systems. These programs all demonstrate the State's commitment to assist local governments in implementing the TMDL recommendations. Additional information about the SRF Program can be found at http://www.mass.gov/eea/agencies/massdep/water/grants/clean-water-state-revolving-fund.html

Public Participation

A public meeting to present the results of and answer questions on this TMDL was held on XXXX in the XXXX meeting room. XXXXX (MassDEP) summarized the Mass Estuaries Project and described the Draft Nitrogen TMDL Report findings. Public comments received at the public meeting and comments received in writing within a 30-day comment period following the public meeting were considered by the Department. This final version of the TMDL report includes both a summary of the public comments together with the Department's response to the comments and scanned images of the attendance sheets from the meeting (Appendix E to be added). MEP representatives at the public meeting included XXXXXXX.

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Appendix A: Overview of Applicable Water Quality Standards

Water quality standards of particular interest to the issues of cultural eutrophication are dissolved oxygen, nutrients, bottom pollutants or alterations, aesthetics, excess plant biomass, and nuisance vegetation. The Massachusetts water quality standards (314 CMR 4.0) contain numeric criteria for dissolved oxygen, but have only narrative standards that relate to the other variables. This brief summary does not supersede or replace 314 CMR 4.0 Massachusetts Water Quality Standards, the official and legal standards. A complete version of 314 CMR 4.0 Massachusetts Water Quality Standards is available online at http://www.mass.gov/eea/agencies/massdep/water/regulations/314-cmr-4-00-mass-surface-water-quality-standards.html

Applicable Narrative Standards

314 CMR 4.05(5)(a) states "Aesthetics – All surface waters shall be free from pollutants in concentrations that settle to form objectionable deposits; float as debris, scum, or other matter to form nuisances, produce objectionable odor, color, taste, or turbidity, or produce undesirable or nuisance species of aquatic life."

314 CMR 4.05(5)(b) states "Bottom Pollutants or Alterations. All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms."

314 CMR 4.05(5)(c) states, "Nutrients –Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00. Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control."

Description of Coastal and Marine Classes and Numeric Dissolved Oxygen Standards

Excerpt from 314 CMR 4.05(4) (a):

(a) Class SA. These waters are designated as an excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish

harvesting without depuration (Approved and Conditionally Approved Shellfish Areas). These waters shall have excellent aesthetic value.
1. Dissolved Oxygen. Shall not be less than 6.0 mg/l. Where natural background conditions are lower, DO shall not be less than natural background. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

Excerpt from 314 CMR 4.05(4) (b):

(b) Class SB. These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas). These waters shall have consistently good aesthetic value.

1. Dissolved Oxygen. Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.

Waterbodies Not Specifically Designated in 314 CMR 4.06 or the tables to 314 CMR 4.00

Note many waterbodies do not have a specific water quality designation in 314 CMR 4.06 or the tables to 314 CMR 4.00**.** Coastal and Marine Classes of water are designated as Class SA and presumed High Quality Waters as described in 314 CMR 4.06 (4).

314 CMR 4.06(4):

(4) Other Waters. Unless otherwise designated in 314 CMR 4.06 or unless otherwise listed in the tables to 314 CMR 4.00, other waters are Class B, and presumed High Quality Waters for inland waters and Class SA, and presumed High Quality Waters for coastal and marine waters. Inland fisheries designations and coastal and marine shellfishing designations for unlisted waters shall be made on a case-by-case basis as necessary.

Applicable Antidegradation Provisions

Applicable antidegradation provisions are detailed in 314 CMR 4.04 from which an excerpt is provided:

Excerpt from 314 CMR 4.04:
4.04:Antidegradation Provisions

(1) Protection of Existing Uses. In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(2) Protection of High Quality Waters. High Quality waters are waters whose quality exceeds minimum levels necessary to support the national goal uses, low flow waters, and other waters whose character cannot be adequately described or protected by traditional

criteria. These waters shall be protected and maintained for their existing level of quality unless limited degradation by a new or increased discharge is authorized by the Department pursuant to 314 CMR 4.04(5). Limited degradation also may be allowed by the Department where it determines that a new or increased discharge is insignificant because it does not have the potential to impair any existing or designated water use and does not have the potential to cause any significant lowering of water quality.

(3) Protection of Outstanding Resource Waters. Certain waters are designated for protection under this provision in 314 CMR 4.06. These waters include Class A Public Water Supplies (314 CMR 4.06(1)(d)1.) and their tributaries, certain wetlands as specified in 314 CMR 4.06(2) and other waters as determined by the Department based on their outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these waters shall be protected and maintained.

(a) Any person having an existing discharge to these waters shall cease said discharge and connect to a Publicly Owned Treatment Works (POTW) unless it is shown by said person that such a connection is not reasonably available or feasible. Existing discharges not connected to a POTW shall be provided with the highest and best practical method of waste treatment determined by the Department as necessary to protect and maintain the outstanding resource water.

(b) A new or increased discharge to an Outstanding Resource Water is prohibited unless:

1. the discharge is determined by the Department to be for the express purpose and intent of maintaining or enhancing the resource for its designated use and an authorization is granted as provided in 314 CMR 4.04(5). The Department's determination to allow a new or increased discharge shall be made in agreement with the federal, state, local or private entity recognized by the Department as having direct control of the water resource or governing water use; or

2. the discharge is dredged or fill material for qualifying activities in limited circumstances, after an alternatives analysis which considers the Outstanding Resource Water designation and further minimization of any adverse impacts. Specifically, a discharge of dredged or fill material is allowed only to the limited extent specified in 314 CMR 9.00 and 314 CMR 4.06(1)(d). The Department retains the authority to deny discharges which meet the criteria of 314 CMR 9.00 but will result in substantial adverse impacts to the physical, chemical, or biological integrity of surface waters of the Commonwealth

(4) Protection of Special Resource Waters. Certain waters of exceptional significance, such as waters in national or state parks and wildlife refuges, may be designated by the Department in 314 CMR 4.06 as Special Resource Waters (SRWs). The quality of these waters shall be maintained and protected so that no new or increased discharge and no new or increased discharge to a tributary to a SRW that would result in lower water quality in the SRW may be allowed, except where:

(a) the discharge results in temporary and short term changes in the quality of the SRW, provided that the discharge does not permanently lower water quality or result in water quality lower than necessary to protect uses; and

(b) an authorization is granted pursuant to 314 CMR 4.04(5).

(5) Authorizations.

(a) An authorization to discharge to waters designated for protection under 314 CMR 4.04(2) may be issued by the Department where the applicant demonstrates that:

1. The discharge is necessary to accommodate important economic or social development in the area in which the waters are located;

2. No less environmentally damaging alternative site for the activity, receptor for the disposal, or method of elimination of the discharge is reasonably available or feasible;

3. To the maximum extent feasible, the discharge and activity are designed and conducted to minimize adverse impacts on water quality, including implementation of source reduction practices; and

4. The discharge will not impair existing water uses and will not result in a level of water quality less than that specified for the Class.

(b) An authorization to discharge to the narrow extent allowed in 314 CMR 4.04(3) or 314 CMR 4.04(4) may be granted by the Department where the applicant demonstrates compliance with 314 CMR 4.04(5)(a)2. through 314 CMR 4.04(5)(a)4.

(c) Where an authorization is at issue, the Department shall circulate a public notice in accordance with 314 CMR 2.06. Said notice shall state an authorization is under consideration by the Department, and indicate the Department's tentative determination. The applicant shall have the burden of justifying the authorization. Any authorization grantedpursuant to 314 CMR 4.04 shall not extend beyond the expiration date of the permit.

(d) A discharge exempted from the permit requirement by 314 CMR 3.05(4) (discharge necessary to abate an imminent hazard) may be exempted from 314 CMR 4.04(5) by decisionof the Department.

(e) A new or increased discharge specifically required as part of an enforcement order issued by the Department in order to improve existing water quality or prevent existing water quality from deteriorating may be exempted from 314 CMR 4.04(5) by decision of the Department.

(6) The Department applies its Antidegradation Implementation Procedures to point source discharges subject to 314 CMR 4.00.

(7) Discharge Criteria. In addition to the other provisions of 314 CMR 4.00, any authorized Discharge shall be provided with a level of treatment equal to or exceeding the requirements of the Massachusetts Surface Water Discharge Permit Program (314 CMR 3.00). Before authorizing a discharge, all appropriate public participation and intergovernmental coordination shall be conducted in accordance with Permit Procedures (314 CMR 2.00).

Appendix B: Summary of the Nitrogen Concentrations for Westport River Estuarine System.

(Excerpted from Howes et. al, 2013, pg. 121). Data means were calculated from sample results collected from 2003 – 2009, with a few data gaps.

Sub-embayment	Monitoring Station	Mean	Standard Deviation (all data)	N	model min	model max	model average
Head Westport	N-0	1.440	0.266	22	1.340	1.346	1.344
Upper East Branch	N-1	1.102	0.295	27	0.889	0.958	0.919
Upper East Branch	N-2	1.009	0.278	27	0.840	0.910	0.879
Upper East Branch	N-3	0.874	0.200	23	0.777	0.906	0.855
Upper East Branch	N-4	0.864	0.223	25	0.647	0.897	0.798
Mid East Branch	E-69	0.851	0.227	44	0.587	0.851	0.735
Mid East Branch	E-56	0.794	0.279	23	0.538	0.712	0.616
Mid East Branch	E-33	0.700	0.186	20	0.441	0.693	0.554
Lower East Branch	E-41	0.626	0.172	19	0.406	0.575	0.492
Lower East Branch	E-30	0.538	0.173	21	0.302	0.518	0.414
Lower East Branch	E-26	0.534	0.192	22	0.293	0.485	0.389
Lower West Branch	W-12	0.649	0.253	41	0.383	0.595	0.491
Lower West Branch	W-9	0.501	0.117	17	0.296	0.511	0.394
Lower West Branch	W-6	0.449	0.081	13	0.286	0.476	0.364
Inlet	N-12	0.477	0.166	22	0.284	0.424	0.329

Appendix C: Stormwater Loading Information

The wasteload allocation for stormwater for this TMDL has been estimated using EPA methodology (EPA 2010) using a geographic information system (GIS). The impervious area in Massachusetts is based on 2005 Impervious cover datalayer released by MassGIS (2014) while the subembayment watersheds are from MEP analysis. For each MEP subembayment watershed the total impervious area was calculated. In addition using an automated GIS script the directly connected impervious area (DCIA) for each MEP subembayment watershed was calculated. The Massachusetts portion of the Westport River Embayment System was analyzed separately from the Rhode Island portion. The estimated WLA for the Massachusetts portions of the Westport River Embayment System is provided in Table C1.

The estimation of WLA from the Rhode Island portions of the Westport River Embayment System was conducted using 2011 Rhode Island Land Use and Land Cover (RI GIS 2015a) and 2011 Impervious Surfaces (RI GIS 2015b) and a GIS system. Two subembayment watersheds, Adamsville Brook and West Branch, have portions of their watersheds in Rhode Island. The calculation of DCIA area was conducted in a manner similar to the EPA method for Massachusetts (EPA 2010) using GIS. Rhode Island uses different landuse categories than Massachusetts. A different mapping of RI landuse categories to the ten common landuse categories used by EPA (2010) was needed. The mapping of RI landuse categories with the relevant EPA landuse category and associated Sutherland equation (similar to EPA 2010) is presented in Table C2. Using the appropriate Sutherland equations for RI landuse categories and RI impervious cover the DCIA area and WLA was estimated using a GIS system (Table C3).

(continued next page)

Table C1: Directly Connected Impervious Area (DCIA) in the Westport River Watershed and WLA for Massachusetts Portion of Westport River Embayment System

Sub-embayment Name	Total Impervious Area in Watershed[1] (acres)	Total Watershed Land Area (acres)	Impervious Area as % of Total Watershed Area	DCIA Area[1] (acres)	DCIA as % of Total Impervious Area	MEP Total Unattenuated Watershed Impervious Load (kg N/day)[2]	MEP Total Unattenuated Watershed Load[2,3] (kg N/day)	WLA (kg N/day)[4]	WLA as % of MEP Total Unattenuated Watershed Load[5]
Old County Road	1,838.1	25,914.6	7%	913.7	50%	11.5	241.0	5.7	2.4%
Kirby Brook	177.7	2,312.7	8%	70.1	39%	1.2	21.0	0.5	2.3%
Snell Creek	90.8	953.6	10%	39.8	44%	0.5	8.1	0.2	2.5%
North East Branch	229.9	3,700.6	6%	76.9	33%	1.2	103.1	0.4	0.4%
South East Branch	248.2	4,752.6	5%	57.6	23%	1.9	69.4	0.4	0.6%
The Let	22.8	873.2	3%	4.4	19%	0.2	5.8	0.0	0.0%
Angeline Brook	81.5	2,113.8	4%	33.0	41%	0.4	34.3	0.2	0.6%
Adamsville Brook[6]	63.9	1,766.6	4%	17.1	27%	2.8	56.0	0.8	1.4%
West Branch[6]	100.3	2,066.3	5%	20.6	21%	0.7	32.9	0.1	0.3%
Westport Harbor	82.8	1,099.7	8%	17.1	21%	0.6	10.3	0.1	1.0%
Total	2,936.1	45,554	6.4%	1,250	43%	21	581.9	8.4	1.4%

[1] Total Impervious Area calculated using GIS using 2005 Impervious cover datalayer released by MassGIS (2014). DCIA calculated per MEP subembayment using GIS and EPA methodology (EPA 2010).[2] From MEP Technical Report, Table IV-2

[3] This includes the unattenuated nitrogen loads from wastewater from septic systems, landfills, fertilizer, agriculture, runoff from both natural and impervious surfaces, atmospheric deposition to freshwater waterbodies

[4] The DCIA Area as % of Total Impervious Area multiplied by MEP Total Unattenuated Watershed Impervious Load (kg N/day)

[5] The WLA (kg N/day) divided by the total watershed load (kg N/day) then multiplied by 100.

[6] Subembayment watershed in both MA and RI, all values for Massachusetts with exception of DCIA as % Total Impervious Area, which is the DCIA as % of Total Impervious Area including all impervious areas (both MA and RI).

Table C2: Mapping of RI Landuse Codes to EPA Land Use Categories and associated Sutherland equation (similar to EPA 2010).

RI Landuse Code	Land Use Description	EPA Code	EPA Description	DCIA% formula
111	High Density Residential (<1/8 acre lots)	5	High Density Residential	DCIA%=0.4(IA%)^1.2
112	Medium High Density Residential (1/4 to 1/8 acre lots)	4	Medium Density Residential	DCIA%=0.1(IA%)^1.5
113	Medium Density Residential (1 to 1/4 acre lots)	4	Medium Density Residential	DCIA%=0.1(IA%)^1.5
114	Medium Low Density Residential (1 to 2 acre lots)	4	Medium Density Residential	DCIA%=0.1(IA%)^1.5
115	Low Density Residential (>2 acre lots)	3	Low Density Residential	DCIA%=0.04(IA%)^1.7
120	Commercial (sale of products and services)	1	Commercial	DCIA%=0.1(IA%)^1.5
130	Industrial (manufacturing, design, assembly, etc.)	2	Industrial	DCIA%=0.1(IA%)^1.5
145	Waste Disposal (landfills, junkyards, etc.)	2	Industrial	DCIA%=0.1(IA%)^1.5
146	Power Lines (100' or more width)	9	Open Land	DCIA%=0.1(IA%)^1.5
161	Developed Recreation (all recreation)	9	Open Land	DCIA%=0.1(IA%)^1.5
162	Vacant Land	9	Open Land	DCIA%=0.1(IA%)^1.5
163	Cemeteries	9	Open Land	DCIA%=0.1(IA%)^1.5
170	Institutional (schools, hospitals, churches, etc.)	6	Urban Public/Institutional	DCIA%=0.1(IA%)^1.5
210	Pasture (agricultural not suitable for tillage)	7	Agriculture	DCIA%=0.01(IA%)^2
250	Idle Agriculture (abandoned fields and orchards)	7	Agriculture	DCIA%=0.01(IA%)^2
220	Cropland (tillable)	3	Low Density Residential	DCIA%=0.04(IA%)^1.7
230	Orchards, Groves, Nurseries	7	Agriculture	DCIA%=0.01(IA%)^2
300	Brushland (shrub and brush areas, reforestation)	8	Forest	DCIA%=0.01(IA%)^2
410	Deciduous Forest (>80% hardwood)	8	Forest	DCIA%=0.01(IA%)^2
420	Softwood Forest (>80% softwood)	8	Forest	DCIA%=0.01(IA%)^2
430	Mixed Forest	8	Forest	DCIA%=0.01(IA%)^2
500	Water	10	Water	NA
600	Wetland	10	Water	NA
740	Mines, Quarries and Gravel Pits	9	Open Land	DCIA%=0.1(IA%)^1.5
750	Transitional Areas (urban open)	9	Open Land	DCIA%=0.1(IA%)^1.5

Table C3: Directly Connected Impervious Area in the Westport River Watershed and WLA for RI Portion of Westport River Embayment System

Subembayment Name	Total Impervious Area in RI Watershed (acres)	Total Watershed RI Land Area (acres)	Impervious Area as % of Total RI Watershed Area	DCIA Area (acres)	DCIA as % of Total Impervious Area[1]	MEP Total Unattenuated Watershed Impervious Load (kg/day)	MEP Total Unattenuated Watershed Load (kg/day)[2]	WLA (kg/d)[3]	WLA as % of MEP Total Unattenuated Watershed Load[4]
Adamsville Brook[5]	66.4	4,202.9	2%	11.6	9%	2.8	56.0	0.2	0.4
West Branch[5]	8.9	120.5	7%	0.4	0%	0.7	32.9	0.0	0.0

[1] DCIA Area (acres) divided by Total Impervious Area (acres) . DCIA as % of Total Impervious Area including all impervious areas (both MA and RI). Total impervious acres calculated using Rhode Island 2011 Impervious Area (RI GIS 2015b).
[2] This includes the unattenuated nitrogen loads from wastewater from septic systems, fertilizer, runoff from both natural and impervious surfaces, atmospheric deposition to freshwater waterbodies
[3] The DCIA Area as % of Total Impervious Area multiplied by MEP Total Unattenuated Watershed Impervious Load (kg N/day)
[4] The WLA (kg N/day) divided by the total watershed load (kg N/day) then multiplied by 100.
[5] Subembayment watershed in both MA and RI, all values for Rhode Island with exception of DCIA as % Total Impervious Area, which is the DCIA as % of Total Impervious Area including all impervious areas (both MA and RI).

Appendix D: Westport River Estuarine System 4 Total Nitrogen TMDLs and 6 Pollution Prevention TMDLs

Sub-embayment	Segment ID	Impairment TMDL Status	TMDL (kg N/day)
North East Branch Westport River	Part of Segment MA95-41	Impaired for nutrients (estuarine bioassessments) and in Category 5 of the Massachusetts 2012 Integrated List.	97.39
West Branch Westport River	MA95-37	Impaired for nutrients (estuarine bioassessments) and in Category 5 of the Massachusetts 2012 Integrated List.	44.05
East Branch Westport River	Part of Segment MA95-41	Impaired for nutrients (estuarine bioassessments) and in Category 5 of the Massachusetts 2012 Integrated List.	67.40
The Let	--	Not impaired for total nitrogen, but TMDL needed since embayments are linked. (Pollution Prevention TMDL)	19.54
Westport River*	MA95-54	Impaired for nutrients (estuarine bioassessments) and in Category 5 of the Massachusetts 2012 Integrated List.	18.48
Old County Road (Bread and Cheese Brook)	MA95-58	Not impaired for total nitrogen, but TMDL needed since waterbodies are linked. (Pollution Prevention TMDL)	111.82
Kirby Brook	--	Not impaired for total nitrogen, but TMDL needed since waterbodies are linked. (Pollution Prevention TMDL)	13.17
Adamsville Brook	--	Not impaired for total nitrogen, but TMDL needed since waterbodies are linked. (Pollution Prevention TMDL)	47.62
Angeline Creek	--	Not impaired for total nitrogen, but TMDL needed since waterbodies are linked. (Pollution Prevention TMDL)	34.30
Snell Creek	MA95-59	Not impaired for total nitrogen, but TMDL needed since waterbodies are linked. (Pollution Prevention TMDL)	3.58
Total for System			457.34

*Segment referred to as Westport Harbor in the MEP Technical report and this TMDL report.