Total Maximum Daily Load (TMDL)
Study for Bacteria in Little Harbor, New Hampshire

Photo: Berrys Brook at sunrise, courtesy of Chris Nash

Prepared by

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Department of Environmental Services
Water Division
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Executive Summary

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's Water Quality Planning Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for waterbodies that do not support designated uses (e.g., swimming, fishing) under technology-based controls for pollution. A TMDL is the maximum amount of a pollutant that a waterbody can receive, and attain or maintain water quality standards for its designated uses. States use water quality monitoring and modeling to determine the TMDL for each pollutant for the waterbody.

In the broader sense of the term, a TMDL refers to a detailed plan that identifies the pollutant reductions a waterbody needs to meet New Hampshire's water quality standards and develops a strategy to implement those reductions in order to restore the water quality. The general process by which TMDLs are developed includes identifying the problem pollutant, establishing the water quality goals or target values needed to achieve water quality standards, identifying the specific sources contributing the pollutant of concern, and then assigning a specific load allocation to each of the sources. Follow-up monitoring is needed to ensure that the implemented TMDL results in the attainment of the targeted water quality standard. All TMDLs are subject to public review and comment and must be submitted to the United States Environmental Protection Agency (EPA) for review and approval.

The TMDL discussed in this report is for bacteria in Little Harbor in Portsmouth, New Castle, and Rye, New Hampshire (see Figure 1). Water quality in Little Harbor does not support designated uses because measurements of fecal coliform and enterococcus concentrations exceed state water quality standards for shellfish consumption and primary contact recreation (e.g., swimming), respectively.

The TMDL study for bacteria in Little Harbor began in May 2003. The New Hampshire Department of Environmental Services (DES) used a combination of water quality monitoring and modeling to develop the TMDL. Water samples were collected from stormwater outfall, river and estuarine stations, and then analyzed for bacteria indicator species. These water quality data were used to refine assumptions for the Watershed Treatment Model, developed by the Center for Watershed Protection, which predicts annual loads of bacteria and other pollutants based on land use in the watershed draining to the waterbody.

Water quality sampling data show that bacteria loads to Little Harbor need to be reduced by 12 percent in order to attain water quality standards. The land use model predicts a current load of 287,907 billion fecal coliform organisms per year to Little Harbor. Therefore, the TMDL for this waterbody is 253,814 billion organisms per year (695.4 billion organisms per day).

DES has assigned waste load and load allocations to specific point and nonpoint sources, respectively, that would reduce the bacteria loads to the TMDL. The allocations were set in the following way. Marina and boat discharges received a waste load allocation of zero because these discharges are illegal and have the most direct effect on harbor water quality. Allocations

for illicit connections and failing septic systems were also set to zero because these discharges are illegal. The load allocations for all non-point source discharges of urban, rural land, and forest stormwater were set equal to the modeled loads because these discharges are either "naturally occurring" or outside of the jurisdiction of the MS4 permits. Finally, the waste load allocation for urban stormwater from municipal separate storm sewer systems (MS4) in Portsmouth, Rye and New Castle was set at 5% below the modeled load so that the total load to the harbor would be reduced by the target amount (12%) with an explicit margin of safety. The TMDL and allocations for the Little Harbor assessment unit are shown on Table 14.

The allocations set in the TMDL have two direct regulatory implications.

- For the municipalities of Portsmouth, Rye and New Castle, the municipality will need to modify its stormwater management program for the MS4 permit to be consistent with the TMDL. DES believes that the best management practices already planned by the municipalities will be mostly sufficient to achieve the goals of the TMDL. However, municipalities will have to detect and eliminate illicit discharges to the stormwater system throughout their jurisdiction, not just within the urbanized areas. There are also additional reporting requirements listed under Sections 1(D)(3) and 1(D)(4) of the MS4 permit.
- Projects in the watershed that require a DES Site Specific Permit will need to demonstrate how loadings of the pollutant from the project site, both during and after construction, will be minimized to the maximum extent practicable with best management practices or other measures. At a minimum, projects will be expected to not increase pollutant loadings.

EPA and DES agree that for highly variable pollutants, such as bacteria, a phased implementation approach should be used to reduce loadings to the TMDL. DES will work with stakeholders (e.g., municipalities, NPDES permittees, marinas, landowners) to develop and implement plans to reduce loadings, usually beginning with the easiest sources first. Then DES will test the surface waters to determine the effect of these control measures. If water quality standards are met, no further reductions are necessary. If not, the process is repeated with other sources. The iterative approach is expected to take 5 years or more. If a point is eventually reached where all sources of the pollutant have been removed to the maximum extent practicable, and the waterbody is still not meeting water quality standards, it may then be appropriate to investigate revising the water quality standard for the waterbody in question, in accordance with Env-Ws 1709.

A full list of the actions that will be taken to reach the goal of this TMDL is provided in the Implementation Plan (Section 6).

1. Introduction

a. Background

Section 303(d) of the Clean Water Act (CWA) and EPA's Water Quality Planning Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water quality limited segments that are not meeting designated uses under technology-based controls for pollution. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollutant sources and instream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources.

b. Purpose of this study

The purpose of this study is to develop a TMDL for bacteria in Little Harbor located in the towns of Portsmouth, Rye, and New Castle, New Hampshire. The goal is to reduce bacteria loads to the harbor so that water quality standards for all the designated uses affected by bacteria pollution are met in all areas of the harbor.

The 0.46 square miles (306 acres) of estuarine waters in Little Harbor are divided into three assessment units for New Hampshire's §305(b) and §303(d) reporting. These assessment units are shown on Table 1 and Figure 1**.** The assessment units for Little Harbor and Witch Creek/Berrys Brook are on New Hampshire's 2004 §303(d) list because measurements of fecal coliform concentrations exceed State surface water quality standards for shellfish consumption. The Little Harbor assessment unit is also listed as impaired for primary contact recreation (e.g., swimming) due to enterococcus concentrations greater than State standards for tidal waters.

The third assessment unit in the harbor is the Wentworth-by-the-Sea marina. The DES Shellfish Program has classified this area as Prohibited to shellfish harvesting following the protocols from the National Shellfish Sanitation Program which require Prohibited "safety zones" around marinas where there is a high risk of raw sewage discharge and/or possible contamination from poisonous or deleterious substances (ISSC, 2003). However, sufficient water samples have not been collected from this assessment unit to show whether or not State water quality standards are being met. Therefore, this assessment unit is not shown as impaired due to bacteria on the 2004 §303(d) list.

Three assessment units that are adjacent to Little Harbor are shown on Figure 1: Back Channel, Lower Sagamore Creek, and Upper Sagamore Creek. These three units are either classified as safety zones or are unclassified for shellfishing. None of these units are on New Hampshire's 2004 §303(d) list for shellfishing impairments due to bacteria.

This TMDL study will focus on the Little Harbor assessment unit because this is the only assessment unit of those listed above for which sufficient information is available to support a TMDL. The pollutant for this TMDL will be bacteria (both fecal coliforms and enterococcus). However, bacteria is not the only pollutant of concern in Little Harbor. All of the assessment

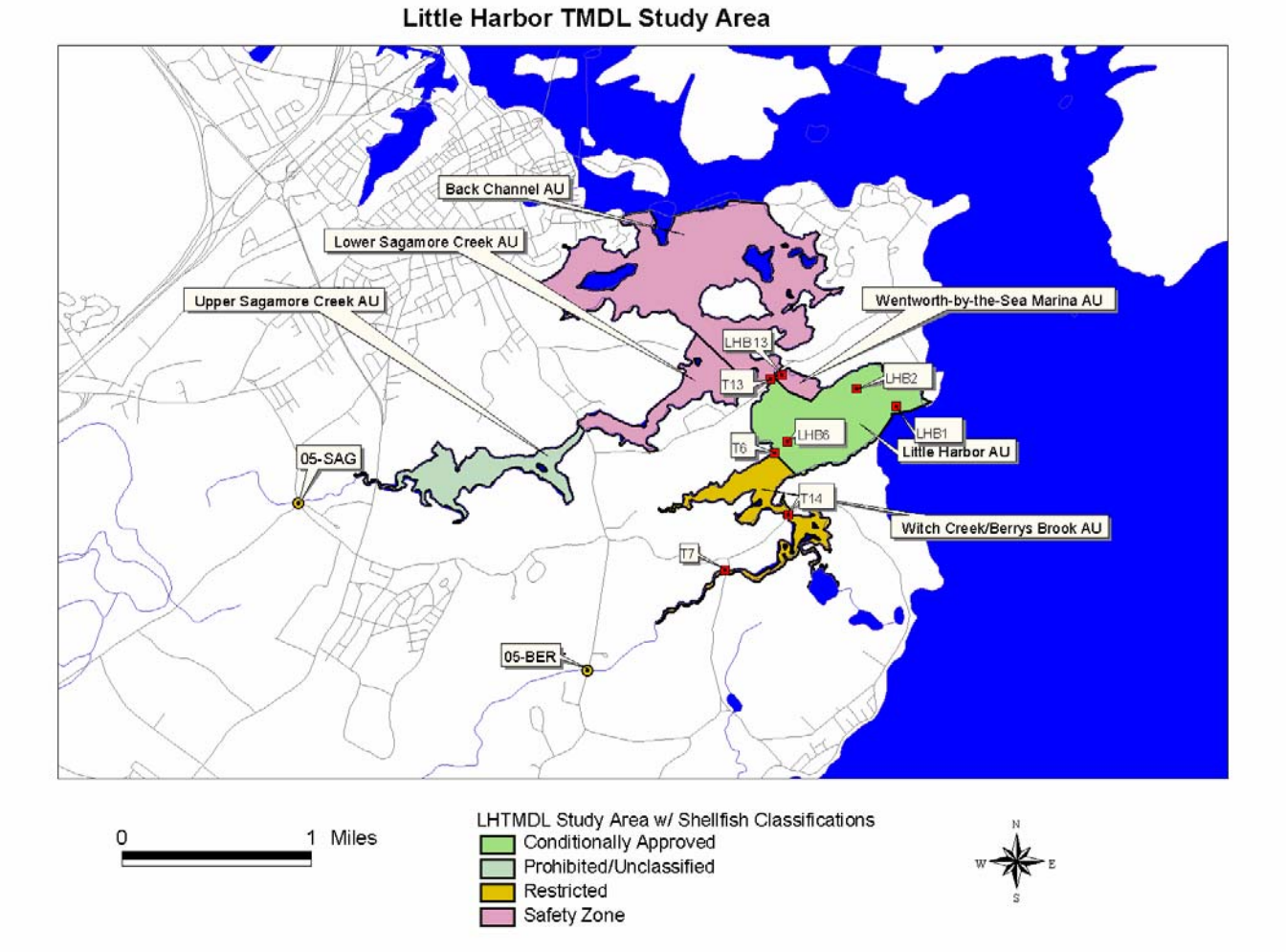
units for New Hampshire's coastal waters are also listed as impaired for fish and shellfish consumption due to polychlorinated biphenyl, dioxin, and mercury concentrations in fish tissue and lobster tomalley. Because of the levels of pollutants found in New Hampshire and neighboring states, the N.H. Department of Health and Human Services has issued state-wide advisories against consumption of certain species of fish and lobster tomalley. The sources of the contaminants in the fish tissue and lobster tomalley are thought to be more regional (e.g., atmospheric deposition) than local. Therefore, this TMDL will only address the bacteria pollution in Little Harbor, which has localized sources.

Table 1: DES assessment units in Little Harbor (2004)

Assessment Unit ID	Name	Area	Impaired Use	NSSP Classification	303(d) Impairment	Source(s)
NHEST600031002-02	Little Harbor	198 ac. 0.30 sq.mi.	Shellfishing	Conditionally Approved	Total Fecal Coliform	Source Unknown; Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)
			Primary Contact Recreation	NA	Enterococcus	Source Unknown
NHEST600031002-01	Witch Creek/ Berrys Brook	93 ac. 0.14 sq.mi.	Shellfishing	Restricted	Total Fecal Coliform	Source Unknown
NHEST600031001-08	Wentworth-by-the-Sea Marina	15 ac. 0.02 sq.mi.	NA	Safety Zone	NA	NA

*All AU's are also listed as "Not Supporting" for fish consumption and shellfishing because of state-wide advisories issued by the N.H. Department of Environmental Services, Environmental and Occupational Health Unit, for PCB, dioxin, and Hg contamination.

Figure 1: DES assessment units in the Little Harbor area, 2004



2. Problem Statement

a. Waterbody Description

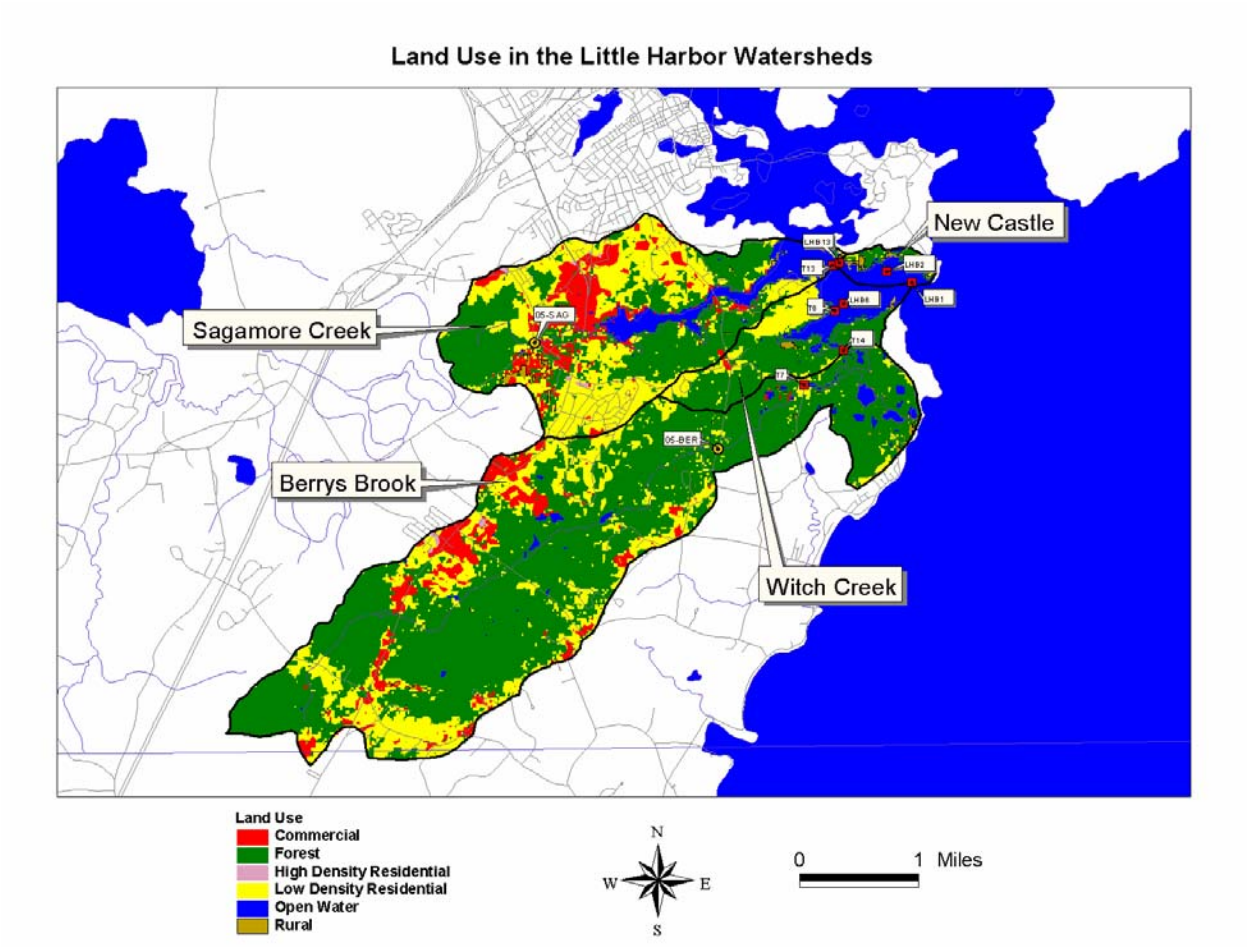
Little Harbor is in the coastal drainage watershed of New Hampshire. The Little Harbor watershed consists of four subwatersheds. Berrys Brook drains 4,256 acres of mainly forested land in Rye and Portsmouth (the watershed also covers negligible areas in Greenland and North Hampton). Sagamore Creek has a smaller watershed than Berrys Brook (2,151 acres), but more of the land in this watershed is developed. The Witch Creek and New Castle watersheds are small areas in Rye and New Castle, respectively, that drain directly to Little Harbor. The land use in the subwatersheds draining to Little Harbor is shown in Table 2 and Figure 2.

Table 2: Land use in the Little Harbor watershed

Category	Berrys Brook	Sagamore Creek	Witch Creek	New Castle	Total	Percent
Low Density Residential	843	763	137	7	1,750	24%
High Density Residential	7	10	0	0	18	0%
Commercial	275	287	4	0	566	8%
Forest	3,057	867	332	33	4,289	60%
Rural	27	47	9	16	99	1%
Open Water	47	176	161	80	464	6%
Total	4,256	2,151	643	136	7,186	100%

Source: 1992 MRLC Land Use/Land Cover
Units: acres

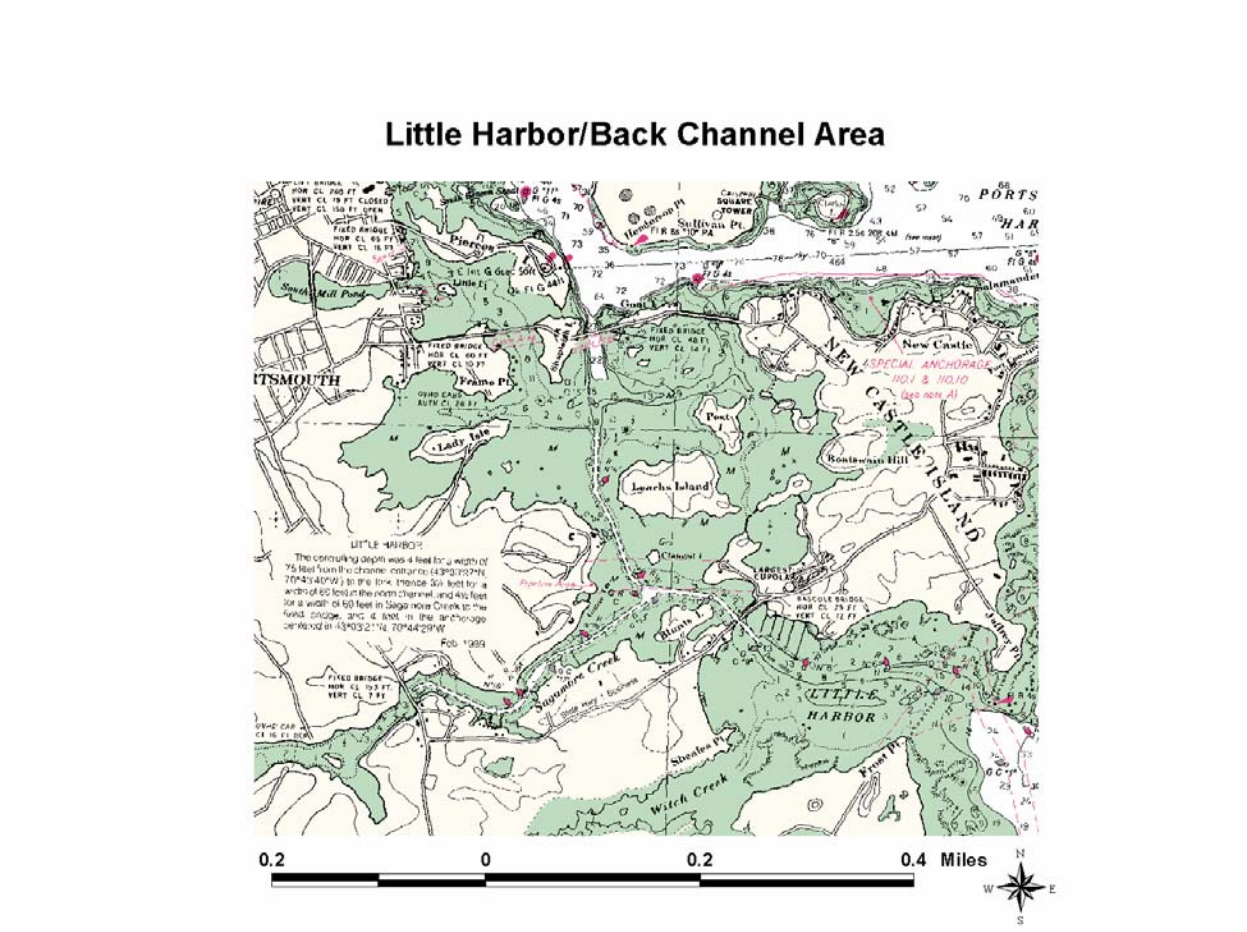
Figure 2: Land use in the Little Harbor watersheds



Both Berrys Brook and Sagamore Creek have freshwater inputs but are dominated by tidal flushing. The water quality stations at 05-BER and 05-SAG are located at the head of tide for Berrys Brook and Sagamore Creek, respectively. The hydrology in Little Harbor and Back

Channel area is complicated but it appears that most of the flow from Sagamore Creek passes in and out of Little Harbor, while most of the water in Back Channel passes out to the Piscataqua River to the north (see Figure 3). This is a simplification of the system but it is reasonable and it is confirmed by dye studies conducted by the DES Shellfish Program (DES, 2001, Bridges 2001). There is very little freshwater input to Witch Creek. The New Castle portion of the watershed is exclusively overland flow and stormwater runoff through culverts.

Figure 3: Hydrology in the Little Harbor/Back Channel Area



The Little Harbor and Witch Creek/Berrys Brook assessment units contain seven flats for recreational harvesting of soft shell clams. Jones and Langan (1996) surveyed these flats and estimated the standing crop of harvestable clams to be 530 bushels. The majority of the harvestable clams are in the Little Harbor assessment unit. The flats have not been surveyed since 1996.

Despite being a soft-shell clam fishery, the clam flats in Little Harbor are often closed due to bacteria pollution. The DES Shellfish Program is responsible for classifying shellfish growing areas in New Hampshire. DES uses a set of guidelines and standards from the National Shellfish

Sanitation Program (NSSP) for classifying shellfish growing areas (ISSC, 2003). The latest classifications for the waters in the Little Harbor area are shown on Table 1 and Figure 1.

The "conditionally approved" classification for the Little Harbor assessment unit means that this area is open during dry weather but closed after a rainfall greater than the rainfall closure threshold. The current rainfall closure threshold is 0.5 inches. The 0.5 inch threshold is based on an analysis of fecal coliform concentrations in the harbor after storms of various rainfall amounts (DES, 2001; DES, 2004a). The fecal coliform concentrations consistently meet the NSSP standards for storms with less than 0.5 inches of rainfall, but not after greater rainfall amounts. Depending on the weather in a given year, the clam flats are closed due to rainfall approximately 50% of the harvesting weekends in November through May (DES, 2005b).

The flats are closed by the N.H. Fish & Game Department in June, July, and August for resource conservation reasons. DES keeps the flats closed in September and most of October because of the unacceptably large risk of boat sewage contamination while boats are still moored in the harbor.

Therefore, although Little Harbor is a major soft-shell clam fishery, the use of this resource is significantly restricted due to bacterial pollution. The Little Harbor assessment unit with the greatest clam resource is closed to shellfishing after rainfalls greater than 0.5 inches between November to May.

b. Applicable Water Quality Standards and Water Quality Numeric Targets

i. Overview

Water Quality Standards determine the baseline water quality that all surface waters of the State must meet in order to protect their intended uses. They are the "yardstick" for identifying where water quality violations exist and for determining the effectiveness of regulatory pollution control and prevention programs. The standards are composed of three parts: classification, criteria, and antidegradation regulations.

Classification of surface waters is accomplished by state legislation under the authority of RSA 485-A:9 and RSA 485-A:10. By definition, (RSA 485-A:2, XIV), "surface waters of the state means streams, lakes, ponds, and tidal waters within the jurisdiction of the state, including all streams, lakes, or ponds, bordering on the state, marshes, water courses and other bodies of water, natural or artificial."

All State surface waters are either classified as Class A or Class B, with the majority of waters being Class B. DES maintains a list which includes a narrative description of all the legislative classified waters. Designated uses for each classification may be found in State statute RSA 485-A:8 and are summarized below.

Classification	Designated Uses
Class A -	These are generally of the highest quality and are considered potentially usable for water supply after adequate treatment. Discharge of sewage or wastes is prohibited to waters of this classification.
Class B -	Of the second highest quality, these waters are considered acceptable for fishing, swimming and other recreational purposes, and, after adequate treatment, for use as water supplies.

Tidal waters, such as the Little Harbor assessment unit, are Class B waters.

DES has developed a Comprehensive Assessment and Listing Methodology (DES, 2004b) in which the specific designated uses for New Hampshire waters have been defined as shown in the following table.

Table 3: Designated uses for New Hampshire waters

Designated Use	DES Definition	Applicability
Aquatic Life	Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms.	All surface waters
Fish Consumption	Waters that support fish free from contamination at levels that pose a human health risk to consumers.	All surface waters
Shellfish Consumption	Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers	All tidal surface waters
Drinking Water Supply	Waters that with conventional treatment will be suitable for human intake and meet state/federal drinking water regulations.	All fresh surface waters
Primary Contact Recreation (i.e. swimming)	Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life.	All surface waters

The second major component of the water quality standards is the "criteria." These are numeric or narrative criteria which define the water quality requirements for Class A or Class B waters. Criteria assigned to each classification are designed to protect the legislative designated uses for each classification. A waterbody that meets the criteria for its assigned classification is considered to meet its intended use. Water quality criteria for each classification may be found in RSA 485-A:8, I-V and in the State of New Hampshire Surface Water Quality Regulations (Env-Ws 1700).

The third component of water quality standards are antidegradation provisions which are designed to preserve and protect the existing beneficial uses of the State's surface waters and to

limit the degradation allowed in receiving waters. Antidegradation regulations are included in Part Env-Ws 1708 of the New Hampshire Surface Water Quality Regulations. According to Env-Ws 1708.02, antidegradation applies to the following:

* All new or increased activity, including point and nonpoint source discharges of pollutants that would lower water quality or affect the existing or designated uses.
* A proposed increase in loadings to a waterbody when the proposal is associated with existing activities.
* An increase in flow alteration over an existing alteration.
* All hydrologic modifications, such as dam construction and water withdrawals.

ii. Water Quality Standards Most Applicable to Pollutant of Concern

There are three designated uses for tidal waters that are relevant to bacteria pollution: shellfishing, primary contact recreation, and secondary contact recreation (e.g., boating). The water quality standards applicable to these three designated uses are provided below.

The water quality standards for shellfishing waters are the NSSP standards for "approved" shellfish harvesting areas: a geometric mean for fecal coliforms not to exceed 14 MPN/100ml and a 90th percentile not to exceed 43 MPN/100ml as determined using NSSP protocols (RSA 485-A:8, V; ISSC, 2003). The NSSP guidelines include other factors besides attainment of these standards for growing area classifications (e.g., completion of sanitary surveys).

The water quality standards for primary contact recreation are: tidal waters used for swimming purposes shall contain not more than either the geometric mean based on at least three samples obtained over a 60 day period of 35 enterococci per 100 mL, or greater than 104 enterococci per 100 mL in any one sample, unless naturally occurring (RSA 485-A:8, V).

There are no water quality standards for secondary contact recreation. However, for the purposes of determining impaired waters for the 305b/303d lists, DES uses enterococci concentrations greater than five times the primary contact recreation standards to determine secondary contact recreation use support (DES, 2004b).

iii. Targeted Water Quality Goals

The goal for this TMDL is for the bacteria concentrations in the Little Harbor assessment unit to meet all the water quality standards for all the designated uses affected by bacteria pollution: shellfishing, primary contact recreation, and secondary contact recreation. Of these three designated uses, the water quality standards for shellfishing are the most stringent. Therefore, the targeted goal for this TMDL is for the water quality in Little Harbor to meet both aspects of the NSSP shellfishing standard (geomean and 90th percentile concentrations) as measured in accordance with NSSP protocols. It is expected that bacteria loading reductions needed to meet the NSSP standards will also cause primary and secondary contact recreation standards to be met. Follow-up monitoring, discussed in Section 6(b)(ii), will include measurements of both

fecal coliforms and enterococci so that the water quality standards for all the designated uses can be assessed.

3. Little Harbor Receiving Water Quality Characterization

Data from the DES Shellfish Program were used to characterize the baseline concentrations of fecal coliforms (FC) in Little Harbor.

There are six DES Shellfish Program stations in the Little Harbor assessment unit. Figure 1 shows that these stations are spaced around the assessment unit. LHB6 and T6 are located at the mouth of the Witch Creek/Berrys Brook tributary. LHB13 and T13 monitor the discharge from Sagamore Creek. LHB2 is approximately 500 feet from the major stormwater culvert on the New Castle shoreline. Finally, LHB1 captures the water quality at the mouth of the harbor.

The DES Shellfish Program monitors these stations using a systematic random sampling design in accordance with NSSP protocols. Specifically, approximately eight to ten sampling dates during the year, emphasizing the open season (November to May), are chosen in advance for each station and samples are collected on these dates regardless of the weather. While these dates are not chosen at random, the weather patterns are random so the samples are effectively randomized across a range of possible weather conditions.

To calculate the water quality statistics for the receiving waters all of the systematic random fecal coliform measurements were compiled from the six stations in Little Harbor from 1993 to 2004. Each measurement was related to cumulative precipitation value consisting of the precipitation recorded in Portsmouth on the day of sample collection (if the storm occurred before the sample was collected) plus the total precipitation recorded during the preceding two days. All data used for these calculations have passed the quality assurance protocols of the DES Shellfish Program.

In addition to the fecal coliform data from the DES Shellfish Program, information on the results of two microbial source tracking studies and measurements of enterococci concentrations at the harbor stations are also presented in Sections 3(c) and 3(d), respectively.

a. Methods for Calculating Water Quality Statistics

The two components of the water quality standard for fecal coliforms in shellfishing waters are the geometric mean ("geomean") and the 90th percentile ("90th%ile") concentrations. These two statistics are calculated following NSSP guidance using the following equations:

$$Geomean = 10^{x}$$

$$90th\%ile = 10^{(x+1.28 \cdot s_x)}$$

where
x = the mean value of log transformed FC concentrations (base 10)
s_x = the standard deviation of the log transformed FC concentrations (base 10)

These statistics are designed for use with data collected during the systematic random sampling program in order to accurately represent the distribution of fecal coliform concentrations in the assessment unit.

b. Little Harbor Water Quality Statistics

Table 4 summarizes the geomean and 90th percentile fecal coliform concentrations for the six NSSP stations in Little Harbor using all the systematic random data from 1993 to 2004. The table has three components. The "a" table contains the statistics for all of the samples combined. The "b" and "c" tables show the statistics for just the dry and wet-weather samples, respectively. Results that are higher than NSSP standards are highlighted in yellow.

These statistics illustrate that the fecal coliform concentrations in the Little Harbor assessment unit nearly meet both components of the standard during all conditions and certainly meet the standard during dry weather. The highest concentrations were at LHB13 and T6, at the mouths of Sagamore Creek and Witch Creek/Berrys Brook, respectively.

There were relatively few systematic random samples collected during wet weather. Statistics were only calculated for stations with at least 10 wet weather samples. The stations with sufficient data show that fecal coliform concentrations are higher during wet weather. These observations match the conclusions of the DES Shellfish Program from their most recent triennial report on the Little Harbor area (DES, 2005a). The only difference is that the DES Shellfish Program uses only the latest 30 samples at each stations, while all the data from 1993 to 2004 are used for this TMDL.

Table 4: Fecal Coliform Concentrations from NSSP stations in Little Harbor

Fecal Coliforms in Systematic Random Samples
1993 to 2004

(a) All Samples

AU	StationID	N	Geomean	90th %ile
Little Harbor	LHB1	30	4.9	21.1
	LHB2	31	5.9	20.4
	LHB6	30	6.1	31.2
	T6	117	7.8	43.7
	LHB13	31	8.0	37.3
	T13	116	5.4	22.1

(b) Dry-Weather Samples

AU	StationID	N	Geomean	90th %ile
Little Harbor	LHB1	28	4.6	19.3
	LHB2	29	5.1	13.8
	LHB6	28	5.6	28.0
	T6	100	6.1	26.8
	LHB13	29	7.1	29.4
	T13	98	4.6	16.3

(c) Wet-Weather Samples

AU	StationID	N	Geomean	90th %ile
Little Harbor	LHB1	2	---	---
	LHB2	2	---	---
	LHB6	2	---	---
	T6	17	33.3	225.5
	LHB13	2	---	---
	T13	18	12.1	71.0

Fecal coliform units in MPN/100ml
Highlighted cells are >14 for geomean or >43 for 90th %ile
Dry-weather defined as <0.5 inches of rain in 48 hours
Wet-weather defined as >=0.5 inches of rain in 48 hours

The DES Shellfish Program data can also be used to illustrate the representativeness of the stations for shoreline regions. Stations T6 and LHB6 are within 500 feet of each other. T6 is sampled from the shore, and LHB6 is sampled from a boat. The same is true for T13 and LHB13. The statistics for all the samples show that T6 has slightly higher fecal coliform concentrations than LHB6, but that the opposite is true for T13 and LHB13. Therefore, there is no evidence of elevated fecal coliform concentrations in the shoreline areas of the harbor. Data from four stormwater sampling rounds for the TMDL in 2003 also illustrate that the concentrations near shore at T6 are not different from those sampled at LHB6 (Table 5). This conclusions is supported by the most recent triennial report for the Little Harbor/Back Channel area from the DES Shellfish Program (DES, 2005a).

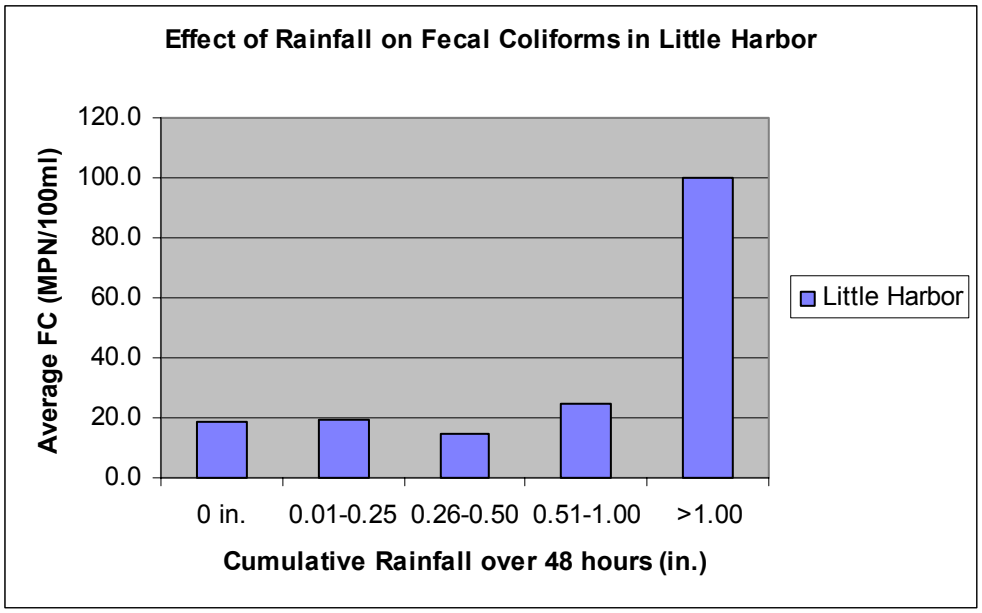
Table 5: Fecal coliform concentrations at T6 and LHB6 during four storms sampled for the TMDL

Date	Time	LHB6	T6
7/11/2003	12:31		40
7/11/2003	12:32	10	
9/4/2003	10:07	<10	
9/4/2003	10:07		10
9/18/2003	11:17	<10	
9/18/2003	11:19		<10
9/19/2003	9:46	10	10

FC concentrations in cts/100ml

In order to illustrate the effect of rainfall on fecal coliform concentrations in the Little Harbor ASSESSMENT UNIT, additional data from non-systematic random sampling by the DES Shellfish Program were compiled and stratified by rainfall amount. These data were collected during rainfall studies and other targeted sampling events, including two rounds collected coincident with stormwater sampling for this TMDL. In Figure 4, the average fecal coliform concentrations during different size storms are shown to increase with increasing rainfall amount, especially for storms with >1 inch of precipitation.

Figure 4: Geomean concentration of fecal coliforms in Little Harbor after different size storms



Data Source: DES Shellfish Program, 1993-2004, all data
Smallest sample size is the >1.00 in. category with samples for the Little Harbor assessment unit.

The effect of rainfall on harbor concentrations can also be illustrated anecdotally using data from the harbor stations that was collected during four storms for the TMDL. Table 6 shows how the average and maximum concentrations increase on days with larger rainfall amounts.

Table 6: Fecal coliform concentrations at harbor stations during four storms for the TMDL

Fecal Coliform Concentrations at NSSP Harbor Stations

Station	7/11/2003	9/4/2003	9/18/2003	9/19/2003
LHB1	<10	10		
LHB13	60	20	<10	10
LHB16	20	40	<10	<10
LHB18	10	20	<10	<10
LHB19	80	20	<10	<5
LHB2	30	<10		10
LHB5	<10	20	10	<10
LHB6	10	<10	<10	10
LHB8	50	<10	10	<10
LHB9	30	120	10	20
Mean	31	28	10	11
Median	25	20	10	10
Maximum	80	120	10	20
Storm Size	0.65	0.65	0	0
3-day Cumulative Rainfall	0.72	0.87	0.83	0

FC concentrations in cts/100ml

c. Microbial Source Tracking Results

Ribotyping was used to determine the sources of *E. coli* isolates obtained from the Little Harbor area during two recent studies (Jones and Landry, 2004; Jones, 2004).

Jones and Landry (2004) monitored eight stations: five in Sagamore Creek, two in Berrys Brook, and one in Little Harbor. Most of the stations were at specific stormwater sources – not ambient stations. Nineteen samples were collected during June 2001 and June-September 2002. All of the samples were collected during dry weather. Ribotyping analysis identified source species for 47% of the *E. coli* isolates in the water samples. The remaining isolates could not be matched with certainty to patterns in the ribopattern database. Of the identified isolates, the largest proportion, 27%, was from wild animals, followed by birds (9%), humans (9%), and livestock (2%).

Jones (2004) analyzed nine samples from seven stations monitored for the Little Harbor Bacteria TMDL. The stations were ambient river sites on Sagamore Creek and Berrys Brook. Samples were collected during two small storms on June 10 and June 29, 2004. The rainfall totals for these two storms were 0.37 and 0.40 inches, respectively. Thirty percent of the isolates were from wild animals, followed by livestock (18%), birds (16%), and then humans (5%). The species associated with 32% of the isolates were not identified.

The results of the two ribotyping studies indicate that the majority of the bacteria in the Little Harbor water samples under dry weather and light rainfall conditions were from wild animals. However, it should not be assumed that the bacteria sources are the same for significant

stormwater loads. None of the ribotyped samples were collected after precipitation events greater than 0.5 inches, which is the current rainfall closure threshold for the shellfishing area. Moreover, a large proportion of the *E. coli* isolates were not identified. Ribotyping data from Little Harbor during large rainfall events would be interesting and useful. The weather patterns during the Little Harbor TMDL study period did not give DES the opportunity to collect samples under these conditions.

d. Water Quality Relative to Primary Contact Recreation Standards

The water quality standards for primary contact recreation in tidal waters are based on enterococcus concentrations. The standard for the geometric mean concentration of at least three samples over a sixty day period is 35 cts/100ml, while the single sample standard is 104 cts/100ml.

The water in Little Harbor was tested for enterococcus between 2001 and 2004 by several programs. The data from these samples are listed in Table 7. All of the stations are shown on Figure 5. LHPS003 is the only major storm drain in the New Castle portion of the watershed. LHPS003SH is the tidal shoreline area where LHPS003 discharges. NH-0023A (alias NH-0223A) is a station from the National Coastal Assessment that is located in the middle of the harbor.

Over the past three years, two samples from Little Harbor have been higher than the single sample standard for enterococcus. All of these samples were taken during wet weather. This assessment unit would be listed as impaired for primary contact recreation based on the DES Consolidated Assessment and Listing Methodology (DES, 2004b). However, none of the shoreline samples at LHPS003SH contained elevated concentrations of enterococcus.

Table 7: Enterococcus concentrations in tidal water samples

Enterococcus Concentrations in Tidal Water Samples

AU	ProjID	Stationid	Date	Parameter	Result	Units	Lab
Little Harbor	NHEPTWQ	LHB13	5/3/2001	Enterococcus	1	#/100ml	JEL
	NHEPTWQ	LHB13	6/27/2001	Enterococcus	2	#/100ml	JEL
	NHEPTWQ	LHB13	7/12/2001	Enterococcus	2	#/100ml	JEL
	NHEPTWQ	LHB13	8/13/2001	Enterococcus	<5	#/100ml	JEL
	NHEPTWQ	LHB13	9/5/2001	Enterococcus	20	#/100ml	JEL
	NHEPTWQ	LHB6	5/3/2001	Enterococcus	4	#/100ml	JEL
	NHEPTWQ	LHB6	6/27/2001	Enterococcus	>200	#/100ml	JEL
	NHEPTWQ	LHB6	7/12/2001	Enterococcus	3	#/100ml	JEL
	NHEPTWQ	LHB6	8/13/2001	Enterococcus	10	#/100ml	JEL
	NHEPTWQ	LHB6	9/5/2001	Enterococcus	60	#/100ml	JEL
	LHTMDL	LHPS003SH	4/13/2004	Enterococcus	<100	#/100ml	DES
	LHTMDL	LHPS003SH	4/14/2004	Enterococcus	<100	#/100ml	DES
	LHTMDL	LHPS003SH	6/29/2004	Enterococcus	20	#/100ml	DES
	NCATWQ	NH-0223A	4/18/2002	Enterococcus	153	#/100ml	JEL
	NCATWQ	NH-0223A	5/21/2002	Enterococcus	22	#/100ml	JEL
	NCATWQ	NH-0223A	6/18/2002	Enterococcus	3	#/100ml	JEL
	NCATWQ	NH-0223A	7/9/2002	Enterococcus	0.5	#/100ml	JEL
	NCATWQ	NH-0223A	8/27/2002	Enterococcus	2	#/100ml	JEL
	NCATWQ	NH-0223A	9/16/2002	Enterococcus	0.5	#/100ml	JEL
	NCATWQ	NH-0223A	10/2/2002	Enterococcus	0.5	#/100ml	JEL
	NCATWQ	NH-0223A	11/14/2002	Enterococcus	15	#/100ml	JEL
	NCATWQ	NH-0223A	12/12/2002	Enterococcus	0.5	#/100ml	JEL
	NCATWQ	NH-0223A	4/28/2003	Enterococcus	1.75	#/100ml	JEL
	NCATWQ	NH-0223A	5/27/2003	Enterococcus	66	#/100ml	JEL
	NCATWQ	NH-0223A	6/10/2003	Enterococcus	5.75	#/100ml	JEL
	NCATWQ	NH-0223A	7/7/2003	Enterococcus	4.25	#/100ml	JEL
	NCATWQ	NH-0223A	7/21/2003	Enterococcus	1.5	#/100ml	JEL
	NCATWQ	NH-0223A	8/5/2003	Enterococcus	18.5	#/100ml	JEL
	NCATWQ	NH-0223A	9/3/2003	Enterococcus	2.5	#/100ml	JEL
	NCATWQ	NH-0223A	10/21/2003	Enterococcus	1.25	#/100ml	JEL
	NCATWQ	NH-0223A	11/5/2003	Enterococcus	16.5	#/100ml	JEL
	NCATWQ	NH-0223A	12/4/2003	Enterococcus	1	#/100ml	JEL
	LHTMDL	T13	4/13/2004	Enterococcus	<10	#/100ml	DES
	LHTMDL	T13	4/14/2004	Enterococcus	10	#/100ml	DES
	LHTMDL	T13	6/29/2004	Enterococcus	<10	#/100ml	DES

Highlighted cells are >104 Enterococci (Class B standards)
None of the 60 day geometric means (not shown) were greater than 35 cts/100ml (Class B standard)
NHEPTWQ = NH Estuaries Project Tidal Water Quality Monitoring Program
NCATWQ = NHDES/EPA National Coastal Assesment Tidal Water Quality Monitoring Program
LHTMDL = Little Harbor TMDL Study

There is also a concern about the risk posed by direct contact with stormwater. DES monitored *E. coli* concentrations in the only major storm drain that discharges to Little Harbor (LHPS003) over three different storms. The *E. coli* concentrations were below water quality standards for two of the three storms, but were elevated for the third storm on 6/29/04 (Table 8).

Table 8: *E. coli* concentrations in stormwater samples

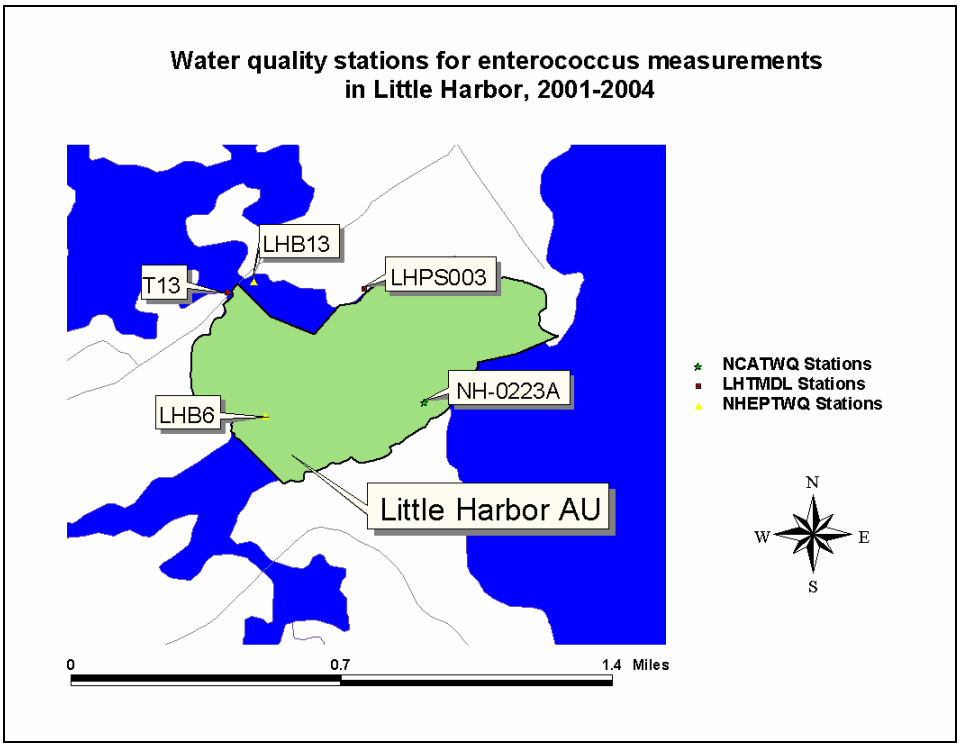
E. Coli Concentrations in Stormwater Samples

ProjID	Stationid	Date	Time	DES Results	JEL Results
LHTMDL	LHPS003	4/13/2004	9:00	<100	
LHTMDL	LHPS003	4/13/2004	12:55	<100	
LHTMDL	LHPS003	4/14/2004	9:45	<100	12
LHTMDL	LHPS003	4/14/2004	10:35	<100	8
LHTMDL	LHPS003	4/14/2004	11:15	<100	5
LHTMDL	LHPS003	6/29/2004	12:50	500	550

Highlighted cells are >406 E.coli (Class B standards)
Units: cts/100ml
DES Result = E.coli concentration measured by DES Laboratory
JEL Result = E.coli concentration measured by UNH/JEL Laboratory

The results of the enterococcus and *E. coli* monitoring in Little Harbor show that this assessment unit would be considered impaired for primary contact recreation during the 2001-2004 period. As with shellfishing, the impairment seems to be limited to wet-weather conditions. In terms of stormwater, some samples had elevated concentrations of *E. coli* but the effect was rapidly diluted at the shoreline.

Figure 5: Water quality stations for enterococcus measurements in Little Harbor, 2001-2004



4. Source Characterization

a. Existing Point Source Loads

Point source discharges include discernible, confined, and discrete conveyances such as the discharge from the effluent pipes of wastewater treatment plants or permitted combined sewer overflows. In addition, discrete stormwater discharges from municipal separate storm sewer systems (MS4) covered by the Phase II stormwater program regulations are considered point sources for this TMDL (EPA, 2002). All point source discharges must have a federal National Pollutant Discharge Elimination System (NPDES) discharge permit.

i. Wastewater Discharges

There are no wastewater treatment plant discharges to Little Harbor. The closest wastewater treatment plan is in Portsmouth, which discharges to the Piscataqua River (DES, 2001; Bridges, 2001).

ii. Combined Sewer Overflows/Sanitary Sewer Overflows

There are no known combined sewer overflows or sanitary sewer overflows that discharge to Little Harbor (Chris Nash, pers. com).

iii. Stormwater Discharges from Phase II MS4 Systems

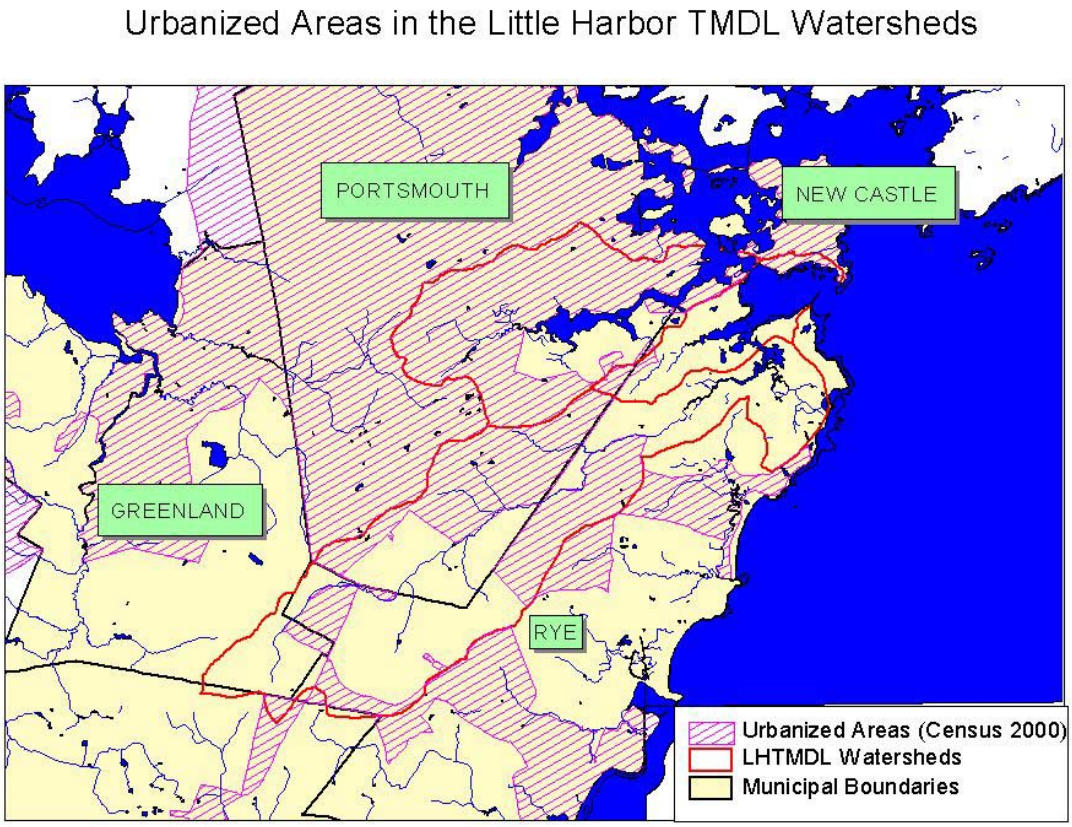
The municipalities of Portsmouth, New Castle, and Rye are covered by the EPA Phase II stormwater program regulations for small municipal separate storm sewer systems (MS4). Therefore, stormwater discharges from discrete pipes and conveyances in the urbanized areas in these municipalities are considered point sources for this TMDL. Over 100 pipes, streams, creeks, and conveyances of stormwater have been identified around Little Harbor and Back Channel by the DES Shellfish Program (DES, 2001; DES, 2004a). During 2003 and 2004, DES monitored the 21 stormwater sources most likely to be large contributors of bacteria based on the size of the pipe and the fecal coliform concentrations that had been measured by the DES Shellfish Program (DES, 2003).

The DES stormwater sampling effort was not able to monitor all of the hundred identified sources in the Little Harbor/Back Channel area. Moreover, overland flow will contribute more stormwater loads that are not channelized. Therefore, DES used the 2003-2004 stormwater sampling data to calibrate a watershed model of the total fecal coliform load from the MS4 systems. The Watershed Treatment Model (version 3.1) developed by the Center for Watershed Protection for EPA was chosen for this project because of it simplicity. The model uses land use classifications and the rational method to predict the stormwater runoff from impervious surfaces in the watershed. The model also predicts loads from illicit discharges to the stormwater system based on the number of housing units in the watershed.

The EPA Phase II stormwater program regulations for MS4s only apply to “urbanized areas” in each municipality. The coverage of urbanized areas was developed from the 2000 US Census and roughly corresponds to census blocks with a population density greater than 1000 people per

square mile. Figure 6 shows the coverage of urbanized areas relative to the town and watershed boundaries.

Figure 6: "Urbanized Area" census blocks in the Little Harbor watershed



Therefore, the Watershed Treatment model was run for the urbanized area in each of the major subwatersheds of Little Harbor: Sagamore Creek, Berrys Brook, Witch Creek, and New Castle. Predicted loads for stormwater runoff from developed lands and illicit discharges to the stormwater system in urbanized areas were considered MS4 discharges. The modeled annual loads from these sources are shown in Table 9.

Table 9: Modeled annual fecal coliform loads from MS4 discharges from urbanized areas

Watershed	Berrys Brook	Sagamore Creek	Witch Creek	New Castle	Total Load
MS4 Stormwater	57,572	87,397	1,887	302	147,157
MS4 Illicit Discharges	272	322	5	3	602

FC Load in billion org/year

For more information on the individual storm drains and the methods used to collect the stormwater samples and calculate the loads, refer to the QA Project Plan for the study (DES, 2003). Summary tables of the fecal coliform concentrations, flow data, and station information for the DES stormwater study are included in Appendix A. Details about the Watershed Treatment Model are provided in Appendix B.

b. Existing Non-Point Source Loads

In general, non-point sources (NPS) of pollutants include all pollutant sources other than point sources. Compared to point sources, NPS of pollution are diffuse and more difficult to quantify. Examples of NPS include stormwater runoff not conveyed through MS4 systems and diffuse sources such as failed septic systems. In the Little Harbor watershed, the three major non-point sources are (1) non-MS4 stormwater runoff, (2) failing septic systems, and (3) discharges from boats in mooring fields or marinas.

i. Non-MS4 Stormwater Runoff

In addition to stormwater runoff from MS4 systems, there will be runoff from developed areas that are outside of the urbanized areas and runoff from undeveloped areas that wash bacteria into Little Harbor and its tributaries. The Watershed Treatment Model (version 3.1) was used to estimate these loads based on the land use characteristics of the watersheds. For urban stormwater, the model was run using the parcels outside of the urbanized areas which have been mapped as being developed. Loads from illicit discharges to the stormwater system were estimated from the number dwellings outside of the urbanized areas. For rural and forest stormwater, all of the land in the watershed in these classifications were used in the model, regardless of the urbanized area boundaries. The resulting annual load estimates for these different types of non-MS4 stormwater runoff are shown in Table 10.

Table 10: Modeled annual fecal coliform loads from developed land outside of urbanized areas, undeveloped forests and rural land

Watershed	Berrys Brook	Sagamore Creek	Witch Creek	New Castle	Total Load
Urban Stormwater	39,543	9,045	5,176	8	53,772
Illicit Discharges	121	22	9	0	152
Rural Land Stormwater	1,052	1,841	343	640	3,875
Forest Stormwater	36,687	10,408	3,985	390	51,471

FC Load in billion org/year

ii. Failing Septic Systems

Failing septic systems throughout the watershed will also contribute bacteria to Little Harbor. The Watershed Treatment Model estimates the loads from this source based on the number of dwellings in the watershed and the percent of the area that is served by a sewer system (see Appendix B for details). Information on these parameters for the watershed was used in the model to predict the annual loads shown in Table 11.

Table 11: Modeled annual fecal coliform loads from failing septic systems

Watershed	Berrys Brook	Sagamore Creek	Witch Creek	New Castle	Total Load
Failing Septic Systems	12,241	5,072	1,099	128	18,539

FC Load in billion org/year

iii. Livestock

There are no significant livestock or agricultural operations in the Little Harbor watersheds.

iv. Marinas/Boats

Many large boats are moored in Little Harbor or docked at the Wentworth-by-the-Sea marina. Releases of untreated sewage from these boats could contribute to the fecal coliform concentrations in the harbor. The Watershed Treatment Model was used to estimate a total load from boat discharge of 12,339 billion organisms per year. Holding tank pump outs by the DES Pump out Boat were accounted for in this calculation. Details for the calculation are shown in Appendix B.

c. Total Loading to Waterbody

Table 12 and Figure 7 show the combined bacteria loads results from the sources discussed in the previous sections for the Little Harbor assessment unit. The largest loads are from MS4 discharges, which account for 51.3% of the total load. Non-MS4 stormwater discharges from developed lands and rural/forest lands contribute another 38%. Discharges from marinas and boats account for 4.3% of the total. Finally, failing septic systems are the cause of 6.4% of the total annual load. The total load from all of the sources is 287,907 billion organisms per year. For comparison, the estimated load to Hampton/Seabrook Harbor was four times higher, 1,278,515 billion organisms per year (DES, 2003b). Fifty one percent of the bacteria delivered to the harbor are from the Berrys Brook watershed (Figure 8). The Sagamore Creek watershed is responsible for another 40% of the total load. Nine percent of the total load is from the Witch Creek and New Castle watersheds.

Table 12: Total fecal coliform loads to the Little Harbor assessment unit

Watershed	Berrys Brook	Sagamore Creek	Witch Creek	New Castle	Total Load	Percent of Total
Point Sources						
Wastewater Discharges	0	0	0	0	0	0.0%
SSOs/CSOs	0	0	0	0	0	0.0%
MS4 Discharges from Urbanized Areas						
Stormwater	57,572	87,397	1,887	302	147,157	51.1%
Illicit Discharges	272	322	5	3	602	0.2%
Non-Point Sources						
Urban Stormwater[1]	39,543	9,045	5,176	8	53,772	18.7%
Illicit Discharges[1]	121	22	9	0	152	0.1%
Rural Land Stormwater	1,052	1,841	343	640	3,875	1.3%
Forest Stormwater	36,687	10,408	3,985	390	51,471	17.9%
Failing Septic Systems	12,241	5,072	1,099	128	18,539	6.4%
Marinas/Boat Discharges	0	0	0	12,339	12,339	4.3%
Total	**147,488**	**114,106**	**12,503**	**13,809**	**287,907**	**100%**

1. Load from developed areas that are not in urbanized areas as defined by the US Census.
2. Load estimates from the Watershed Treatment Model, v 3.1
3. Load Units: billion organisms per year

Figure 7: Fecal coliform loads to the Little Harbor assessment unit from each source

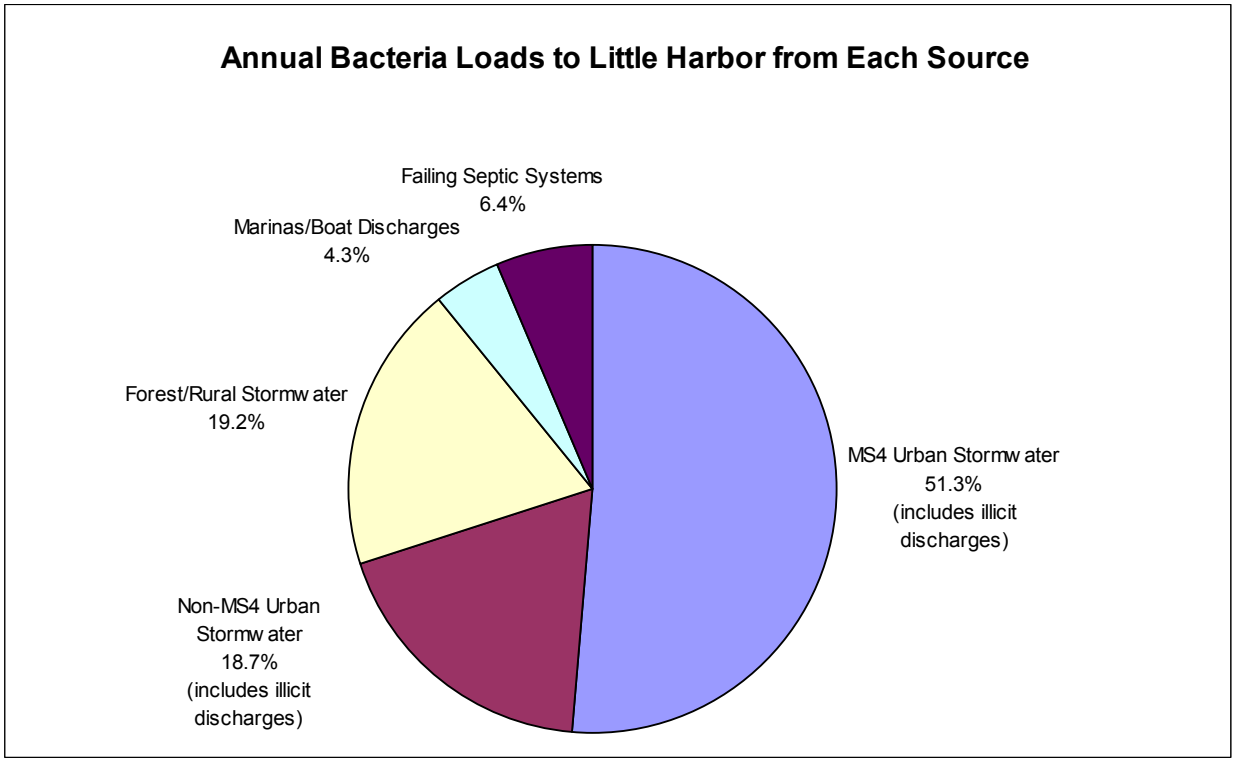
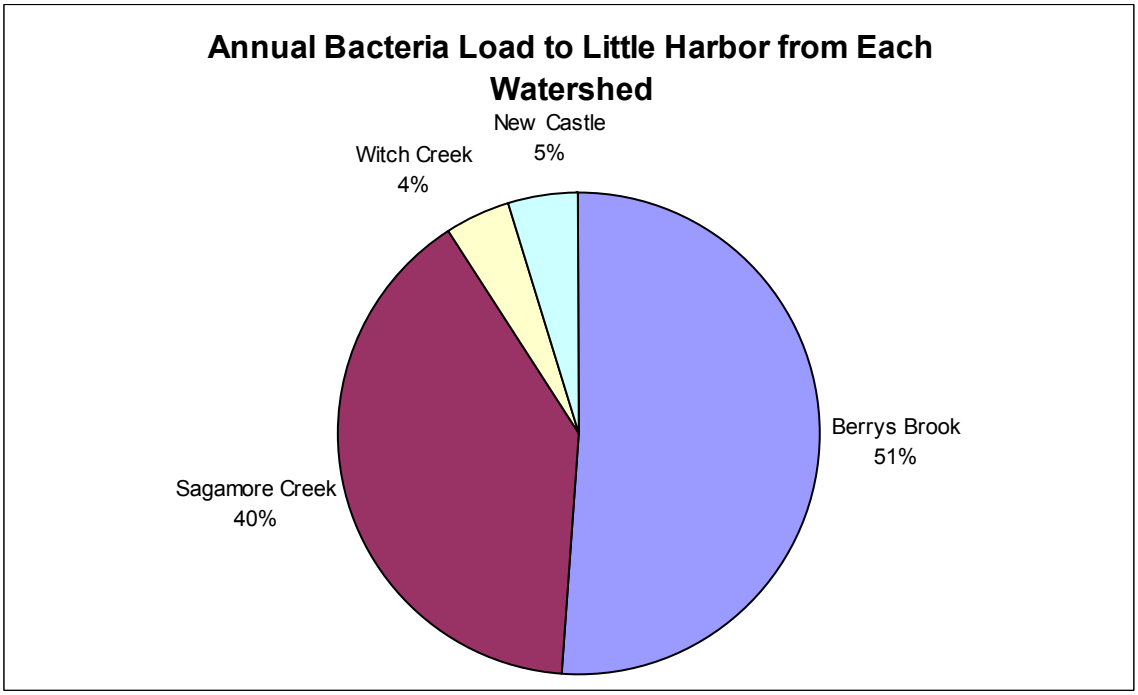


Figure 8: Fecal coliform loads to the Little Harbor assessment unit from each watershed



5. TMDL and Allocations

a. Definition of a TMDL

According to the 40 CFR Part 130.2, the total maximum daily load (TMDL) for a waterbody is equal to the sum of the individual loads from point sources (i.e., waste load allocations or WLAs), and load allocations (LAs) from nonpoint sources (including natural background conditions). Section 303(d) of the CWA also states that the TMDL must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety (MOS) which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

In equation form, a TMDL may be expressed as follows:

$$TMDL = WLA + LA + MOS$$

where:

WLA	=	Waste Load Allocation (i.e. loadings from point sources)
LA	=	Load Allocation (i.e., loadings from nonpoint sources including natural background)
MOS	=	Margin of Safety

TMDLs can be expressed in terms of either mass per time, toxicity or other appropriate measure [40 CFR, Part 130.2 (i)]. The MOS can be either explicit or implicit. If an explicit MOS is used, a portion of the total allowable loading is actually allocated to the MOS. If the MOS is implicit, a specific value is not assigned to the MOS. Use of an implicit MOS is appropriate when assumptions used to develop the TMDL are believed to be so conservative that they are sufficient to account for the MOS.

b. Determination of TMDL (Loading Capacity)

i. Seasonal Considerations/Critical Conditions

Water quality standards for shellfishing are met during dry weather, but not during wet weather. Therefore, the critical condition for this TMDL should be wet weather periods. Changes in fecal coliform concentrations between the seasons are dwarfed by the effect of rainfall. Episodic rainfall events will elevate the 90th percentile fecal coliform concentrations more than the geomean. Therefore, the 90th percentile fecal coliform concentrations should be used to establish the overall loading reductions needed in each of the assessment units.

Moreover, the fecal coliform standards for the shellfishing use are more stringent than the enterococcus standards for primary contact recreation. In Little Harbor, the fecal coliform concentrations at station NH-0023A are typically almost two times higher than the enterococcus concentrations. However, the 90th percentile standard for fecal coliforms (43 MPN/100ml) is less than the single sample standard for enterococcus (104 cts/100ml). Therefore, if the water quality standard for shellfishing is met, it is likely that the primary contact recreation standard will also be met.

ii. Loading Reduction Needed to Achieve Water Quality Standards

The NSSP statistics for fecal coliforms from the two assessment units and the percent reduction needed to achieve the standards are shown in Table 13. The percent reduction is calculated by:

$$Percent\_reduction = \frac{(90th\%ile - WQS \times 0.9)}{90th\%ile}$$

where 90th%ile is the measured 90th percentile concentration and WQS is the water quality standard for shellfishing (43 MPN/100ml). The 90th percentile concentrations were used for the percent reduction calculation because they need a greater percent reduction than the geomean concentrations. For example, if the geomean concentrations were used, the Little Harbor assessment unit would be considered to be meeting standards. The WQS was multiplied by 0.9 to provide a 10 percent margin of safety (discussed below).

Table 13: Percent reduction needed to achieve water quality standards

AU	StationID	N	Geomean	90th %ile	Percent Reduction Needed
Little Harbor	LHB1	30	4.9	21.1	---
	LHB2	31	5.9	20.4	---
	LHB6	30	6.1	31.2	---
	T6	117	7.8	43.7	12%
	LHB13	31	8.0	37.3	---
	T13	116	5.4	22.1	---

Based on the calculations listed in this table, there would need to be a 12% reduction in loadings in Little Harbor before water quality standards are reached. These loading reduction targets are for total loads to the assessment units. Individual sources may require greater reductions to meet standards, especially where localized impacts may occur.

iii. TMDL Calculation and Load Allocation

Allocations were assigned to each of the major sources of bacteria in order to reduce the total loading value by the percentage determined in the preceding section. Table 14 and Figure 9 show the existing loads, allocations and the TMDL for the Little Harbor assessment unit. The allocations were set in the following way. Marina and boat discharges received a waste load allocation of zero because these discharges are illegal and have the most direct effect on harbor

water quality. Allocations for illicit connections and failing septic systems were also set to zero because these discharges are illegal. The load allocations for non-point source discharges of urban, rural land, and forest stormwater were set equal to the modeled loads because these discharges are either "naturally occurring" or outside of the jurisdiction of the MS4 NPDES permits. Finally, the waste load allocation for MS4 stormwater was set at 5% below the modeled load so that the total load to the harbor would be reduced by the target amount (12%) with an explicit margin of safety. The additional implicit margin of safety is discussed in the following section.

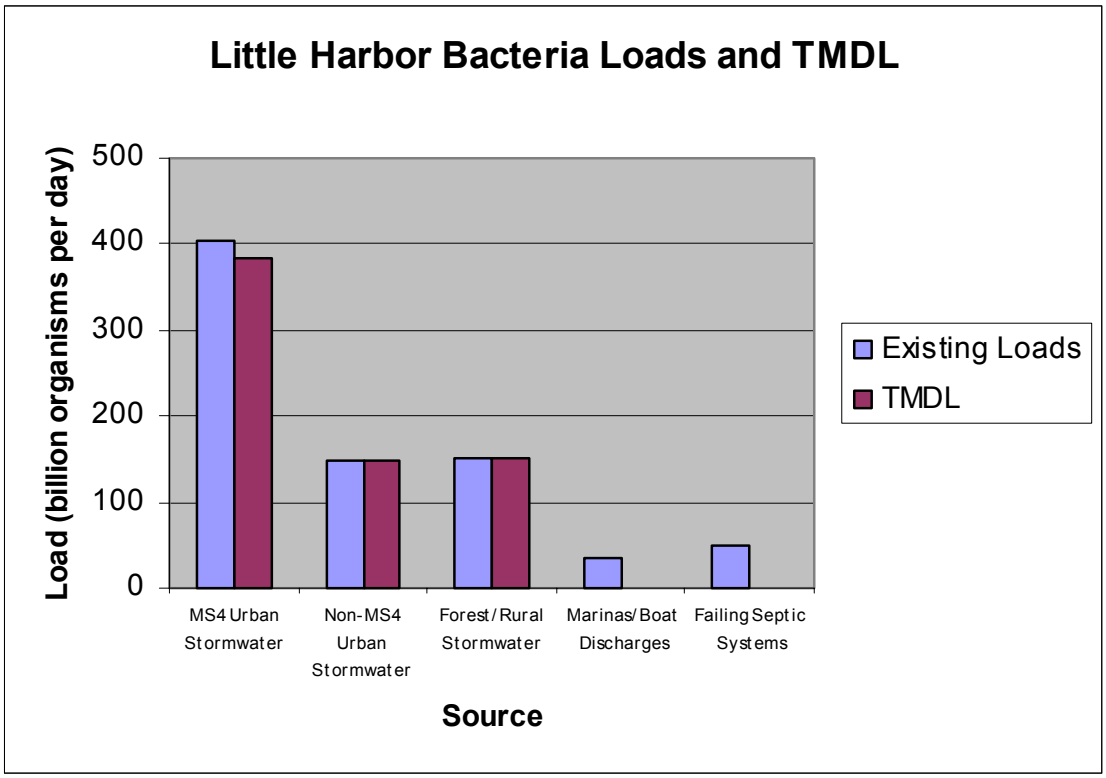
In the table below, allocations for illicit discharges are listed both under MS4 discharges from urbanized areas and non-point sources. The division occurs because some illicit discharges will be located inside the urbanized area, which is the jurisdiction of the MS4 permit. The allocations for illicit discharges in all areas have been set to zero because these sources are illegal.

Table 14: Existing loads, allocations and TMDL for Little Harbor assessment unit

Watershed	Total Load	WLA	LA	MOS	TMDL	Percent Reduction
Point Sources						
Wastewater Discharges	0.0	0.0		Implicit	0.0	0%
SSOs/CSOs	0.0	0.0		Implicit	0.0	0%
MS4 Discharges from Urbanized Areas						
Stormwater	403.2	383.6		Implicit	383.6	5%
Illicit Discharges	1.6	0.0		Implicit	0.0	100%
Non-Point Sources						
Urban Stormwater[1]	147.3		147.3	Implicit	147.3	0%
Illicit Discharges[1]	0.4		0.0	Implicit	0.0	100%
Rural Land Stormwater	10.6		10.6	Implicit	10.6	0%
Forest Stormwater	141.0		141.0	Implicit	141.0	0%
Failing Septic Systems	50.8		0.0	Implicit	0.0	100%
Marinas/Boat Discharges	33.8		0.0	Implicit	0.0	100%
Margin of Safety				12.9	12.9	NA
Total	**788.8**	**383.6**	**299.0**	**12.9**	**695.4**	**12%**

1. Load from developed areas that are not in urbanized areas as defined by the US Census.
2. Load estimates from the Watershed Treatment Model, v 3.1
3. Load Units: billion organisms per day
4. WLA = Waste Load Allocation (i.e., loadings from point sources), LA = Load Allocation (i.e., loadings from nonpoint sources including natural background), MOA = Margin of Safety

Figure 9: Existing loads and TMDL allocations for the Little Harbor assessment unit



iv. Margin of Safety

The loading reduction needed to achieve water quality standards was calculated using a 10% margin of safety subtracted from the standard, which provides an implicit margin of safety for the TMDL. In addition, 1.9% of the TMDL (12.9 billion organisms per day) was held in reserve as an explicit margin of safety.

6. Implementation Plan

a. Statutory/Regulatory Requirements

Section 303(d)(1)(C) of the CWA provides that TMDLs must be established at a level necessary to implement the applicable water quality standard. The following is a description of activities that are planned to abate water quality concerns in Little Harbor.

b. Description of Activities to Achieve the TMDL

i. Implementation Plan

Introduction

The Little Harbor assessment unit is an open bay that covers 198 acres and is well mixed by tidal flushing. DES monitors water quality at six stations. The water quality at all but one of the six stations meets standards. The station that does not meet water quality standards is close to the mouth of the Berrys Brook watershed, which is the largest source of bacteria to the harbor. DES estimates that total bacteria loads to Little Harbor need to be reduced by 12% in order to achieve water quality standards at all the stations.

Based on the model, such a reduction can be achieved by eliminating marina/boat discharges, all illicit discharges and failing septic systems in MS4 urbanized areas, and reducing the load from MS4 stormwater by 5%. DES believes that the waste load allocations for MS4 systems will be met through implementation of existing storm water control measures (see Section 1(D)(3) of the MS4 NPDES permit). Efforts to reduce bacteria loads from Berrys Brook would be the most effective means of achieving water quality in Little Harbor. Therefore, for Little Harbor, DES has: (1) confidence in the representativeness of the water quality data, (2) confidence in the feasibility of the load reduction targets, and (3) clear direction for the most effective implementation actions. Specific goals, schedule, and action items for the implementation plan are listed below. EPA and DES agree that for highly variable pollutants, such as bacteria, a phased implementation approach should be used to reduce loadings to the TMDL.

Goals

- Achieve water quality standards for bacteria in the Little Harbor assessment unit.
- Characterize bacteria concentrations and sources in the Berrys Brook/Witch Creek assessment unit.

Schedule

- 1/1/2006-12/31/2010

DES Action Items

DES has a number of ongoing programs to improve the water quality in Little Harbor. These programs plus additional commitments are listed below:

1. Provide training to municipal staff in the Little Harbor watershed on illicit discharge detection and elimination methods.
2. Continue annual NSSP monitoring at stations LHB1, LHB2, LHB6, LHB13, T14 and T7 and enterococcus monitoring at station NH-0023A in the Little Harbor assessment unit to determine compliance with water quality standards.
3. Continue to operate the DES mobile pumpout boat in the coastal region to remove sewage from vessels in the Little Harbor marina and mooring field. For more information, visit: www.des.state.nh.us/WMB/CVA/nhpumpout.htm
4. Continue to enforce the provisions of the "No Discharge Area" designation for boat sewage in NH's coastal waters. The No Discharge Area designation became effective on September 27, 2005. Information about the No Discharge Area is available at: http://www.epa.gov/fedrgstr/EPA-WATER/2005/September/Day-27/w19252.htm.

The following DES projects are proposed pending funding and staff resources:

5. Secure annual funding from the NH Estuaries Project to be made available to municipalities for stormwater infrastructure mapping and illicit discharge detection and elimination (pending funding).
6. Identify the sources of bacteria to the Berrys Brook/Witch Creek assessment unit using shoreline surveys, water quality bracketing surveys, and wet-weather microbial source tracking sampling (pending funding).
7. Determine representative concentrations of bacteria in the Berrys Brook/Witch Creek assessment unit through expanded monitoring (pending funding).
8. Work collaboratively with municipalities, the NH Estuaries Project, and other organizations to conduct education and outreach regarding septic system maintenance and detection of failing septic systems (pending funding).

MS4 Permittee Action Items

The three communities that surround the Little Harbor and Berrys Brook/Witch Creek assessments (Portsmouth, New Castle, and Rye) are all in the process of complying with the requirements of the NPDES General Permit for Small MS4s. The communities have already made progress on stormwater infrastructure maps and illicit discharge detection and elimination; however, they must do more work by May 1, 2008 to satisfy the NPDES permit requirements. Their ongoing programs to comply with the permit plus other commitments are listed below:

1. Implement all of the best management practices in the Stormwater Management Program (SWMP) listed in the municipality's Notice of Intent for Coverage Under the NPDES General Permit for Stormwater Discharges from Small MS4s.
2. Comply with the TMDL reporting requirements in Sections 1(D)(3) and 1(D)(4) of the MS4 NPDES permit.
3. Install a sewer extension to replace septic systems in the Pleasant Point Drive neighborhood of Portsmouth (this project is already funded and in the design stage).

DES also encourages the City of Portsmouth to consider sewer extension projects for the Walker Bungalow Road and on Sagamore Avenue areas.

4. DES encourages the municipalities to detect and eliminate illicit connections throughout their jurisdiction, not just within the urbanized areas.

EPA Construction General Permit or DES Site Specific Permit Applicant Action Items

According to RSA 485-A:12, it is unlawful to discharge pollutants to a water body that will lower the quality of the waters below the water quality standards. The Little Harbor assessment unit is both listed as not meeting water quality standards for bacteria. Therefore, it is unlawful to add additional bacteria to this assessment unit and the allocation for bacteria loads from new development is implicitly zero. The only reasonable scale on which to enforce this law is for large development projects. Therefore, DES will ask applicants for a DES Site Specific Permit (impacting 2.3 acres of more) to demonstrate per Env-Ws 415.10(d) that the project will not increase bacteria loadings to the Little Harbor assessment unit from pre-development conditions, both during construction and after construction is complete.

Wentworth-by-the-Sea Marina Action Items

In order to achieve the TMDL for Little Harbor, boat discharges of untreated sewage in the Wentworth-by-the-Sea marina and Little Harbor mooring field need to be eliminated. DES currently operates a mobile pumpout boat that services the Little Harbor area. The Wentworth-by-the-Sea Marina already requires that boaters who rent slips and moorings sign a contract which includes a clause prohibiting discharges of sewage. In addition, the marina will undertake the following action items:

1. Continue to operate a sewage pumpout facility at the marina dock.

ii. Monitoring

Data from routine monitoring conducted in accordance with NSSP protocols by the DES Shellfish Program will be used to assess progress toward the goals of this TMDL and compliance with water quality standards for shellfishing.

Enterococci concentrations are monitored at one station in the middle of the Little Harbor between April and December on a monthly frequency. Data from this monitoring program will be used to assess progress toward the goals of this TMDL and compliance with water quality standards for primary and secondary contact recreation.

Individual restoration actions to remove bacteria sources may involve before and after monitoring to document the loading reduction achieved.

7. Public Participation

a. Description of the Public Participation Process

EPA regulations [40 CFR 130.7 (c) (ii)] require that calculations to establish TMDLs be subject to public review. The Little Harbor TMDL has been through three rounds of public review.

The first public comment draft was distributed on November 8, 2004 to the three towns that surround the assessment units: Portsmouth, New Castle, and Rye, NH. The report was also sent to the Wentworth-by-the-Sea marina and condominium association. At the same time, the report was posted on the DES website: www.des.state.nh.us/wmb/TMDL/. Finally, a notice about the report was broadcast to the New Hampshire Estuaries Project Technical Advisory Committee and Shellfish and Living Resources Team (25 addresses total). The public comment period lasted for 30 days (November 8 to December 10, 2004).

DES revised the document based on the comments received and then held a second comment period starting on October 26, 2005. The second draft of the TMDL document was mailed to the three towns that surround the assessment units, the Wentworth-by-the-Sea marina, the Wentworth-by-the-Sea condominium association and the Conservation Law Foundation. The second comment period lasted for 30 days (October 26, 2005 to November 30, 2005).

DES revised the document again based on comments received. The third draft of the TMDL document was sent to the three towns that surround the assessment units, the Wentworth-by-the-Sea marina, EPA, and the Conservation Law Foundation on April 18, 2006. EPA provided some written comments on the third draft document on April 10, 2006 and May 8, 2006. Finally, DES received some additional comments during a meeting with representatives from the City of Portsmouth, the Town of Rye, and EPA on May 16, 2006. The meeting had been requested by the City of Portsmouth in comments received on December 10, 2004 and November 30, 2005. The purpose of the meeting was to discuss the implementation plan for the TMDL.

The comments received and DES' responses are listed in the following section.

b. Public Comment and DES Response

DES received the following comments from the City of Portsmouth on the draft TMDL report during the first comment period. Each comment is followed by the DES response in italics.

<u>General Comments</u>

A Public Meeting or presentation of this study with an opportunity to provide additional comment is requested.

> *Agree. DES will hold a meeting with municipal officials and other interested parties to present the TMDL and to respond to additional comments.*

An executive summary would be appropriate which would include a clear statement of assumptions and data used to generate the TMDL and a description of how this TMDL will be implemented from a regulatory standpoint.

Agree. An executive summary has been added to the report.

The text states that the objective of the implementation plan is to remove human sources of bacteria to the estuary (page 25). However, based on the TMDL study it appears that removal of human sources will not achieve the objective of attainment of designated uses.

See response to last comment.

Specific Comments

Page 2 Table 1 talks about sources for Little harbor including CSO's and SSO's but the report states there are no CSO's or SSO's in this area.

No change. Table 1 lists the assessment units, impairments, and sources of impairments from the DES Assessment Database (ADB) for §305(b)/303(d) reporting. The ADB uses a nationally standardized list of sources of impairment. For general stormwater pollution, the source that is available in the ADB is "Wet weather discharges (Point Source and Combination of Stormwater, SSO, or CSO)." Table 1 is meant to report on the entries in the ADB for the relevant assessment units so it should not be changed.

Page 9 text in paragraph starting "There are six DES…" stations (LHB13 and T13) and (LHB6 and T6) are reversed according to figure 1 page 3.

Agreed. The text has been changed.

Page 10 text in paragraph starting "The following table summarizes…" ends in "highlighted in yellow" but no highlighting found. In particular in Table 4 standards could be listed to refer to exceedences.

Agreed. The yellow highlighting did not reproduce in the copies of the report. A footnote has been added to the table that provides the water quality standards as a reference.

Page 15 Table 7 refers to highlighted cells which do not show up.

See previous comment.

Page 13 Microbial Source Tracking should be an aside. We suggest dropping it from the report and including in the appendix.

No change. The MST data is useful information for the TMDL. The most appropriate place for the MST data is in Chapter 3 "Little Harbor Receiving Water Quality Characterization".

Page 20 Table 12 should state that results are based on Watershed Treatment Model version 3.1.

Agreed. A footnote has been added to Table 12 and Table 13.

It appears the data used in the Watershed Treatment Model version 3.1 (in particular LHPSO54 and LHPSO68 from table B-2 in appendix B) are not in the study area and are used as part of the

model possibly inflating the FC load for stormwater. This may impact the WLA and LA for tables 15 and 16 skewing the results towards MS4 stormwater.

No change. DES collected stormwater data in the Little Harbor and Back Channel area in order to refine the default assumptions in the Watershed Treatment Model. It is true that some of the stations, including LHPS054 and LHPS068, discharge to Back Channel, not Little Harbor. However, these stations are still representative of stormwater discharges in the general area and therefore should be included in the average event mean concentration for the model. The model will be more stable and reliable if all the available data are used to establish the model parameters.

Page 23-25 The text should make the point that by addressing the problems in Witch Creek and Berry's Brook the goal of 12% reduction required for Little Harbor will be surpassed.

See response to last comment.

Page 24 Table 16 the goal of 100% removal of MS4 stormwater load is unrealistic for water quality improvement.

Agree. The 100% removal of MS4 stormwater loads was predicted for the Witch Creek/Berrys Brook assessment unit. After reviewing the public comments, DES has decided that there is not enough water quality data for the Witch Creek/Berrys Brook assessment unit to set an accurate TMDL. Therefore, DES has removed the Witch Creek/Berrys Brook assessment unit from this report. The implementation plan contains tasks to better characterize conditions in Witch Creek/Berrys Brook so that a TMDL can be completed in the future. In the meantime, the goal for achieving water quality standards in the Little Harbor assessment unit is 12% reduction in total loads including a 5% reduction for MS4 stormwater loads. This goal is feasible and realistic.

DES received the following comments on the draft final TMDL report during the second comment period. Each comment is followed by the DES response in italics.

Comments from the City of Portsmouth

We recognize the science to support the model is the best available at the time this work was done (May 2003 through October 2005). However we feel the model is based on a limited data set therefore, any conclusion and reliance on action items identified may not be as successful as believed. Nonetheless, we encourage the State to continue to update the model with additional data, as it becomes available.

> *No change. DES agrees that updating the model is a good idea will perform this task as resources allow.*

Despite our concerns over the model and conclusions of the draft TMDL, the City is committed to its on-going storm water control program and the associated water quality benefits it will bring. The draft report specifies action items that the MS4 permittee is responsible for.

> Implement all of the best management practices in the Stormwater Management Program (SWMP) listed in the municipality's Notice of Intent under the General Permit for Small MS4.
>
> > This action item is consistent with current efforts by the City to conform with regulatory requirements. The City submitted its NOI in September of 2003 and updated the NOI in September 2005. The City has been and continues to operate under its Storm Water Management Plan and Annual reports have been submitted for the past two years of the permit. An implementation schedule was established to meet the goals of the BMPs for the life of the permit. The BMPs will be revised as appropriate when the permit needs to be renewed.
>
> Comply with the TMDL reporting requirements in Section 1 (D) (3) and 1 (D) (4) of the MS4 NPDES permit.
>
> > This is consistent with regulatory requirements. However, we feel the assessment cited within these sections should not be interpreted as meaning sampling only. For example if an illicit discharge is eliminated, it is reasonable to state that BMPs are being met and pollutants are being reduced.
>
> Where possible focus illicit discharge and failing septic systems detection and elimination best management practices from the SWMP on the shoreline areas of the Berrys Brook/Witch Creek and Sagamore Creek watersheds.

> The City's on-going illicit discharge elimination program covers the entire City including the areas covered in the TMDL. Since 2000, the City has identified 16 illicit discharges, 14 of which have been resolved. The remaining two are in the process of investigation and resolution. The City is investigating, with NH DES support, illicit discharges in the Route 1 By-Pass area and is currently scheduling correction of a discharge in the Bartlett Street area.

Install a sewer extension to replace septic systems in the pleasant Point Drive neighborhood of Portsmouth.

> The City is currently preparing a request for proposals (RFP) for engineering design services to extend sewer to the Pleasant Point neighborhood. The construction of this sewer extension is anticipated in the summer of 2006. Final schedule is dependent on funding availability.

No change.

Prior to finalizing this TMDL study the City requests a public meeting with the NHDES, Rye, New Castle and Portsmouth. The intent of the meeting would be to focus on the implementation measures listed in the TMDL to open a dialogue between the affected municipalities and to promote intergovernmental cooperation which will help facilitate achieving the goals of this TMDL study.

No change. DES has agreed to hold a meeting with the municipalities.

Comments from the Conservation Law Foundation

1. Portsmouth's Peirce Island WWTP and associated CSOs must be a part of the Study, and must be assigned a Waste Load Allocation requiring reduced pollutant loadings. A July 2001 dye dispersion study prepared for the U.S. EPA and DES, entitled "Portsmouth WWTP Dye Dispersion Study," demonstrates the close connection between the Peirce Island WWTP and Little Harbor. The study, attached herewith, specifically recommended that shellfish areas in Little Harbor remain closed because necessary dilution was not achieved when the dye initially entered and spread through the shellfishing beds. Also attached is a more recent study – conducted for the City of Portsmouth relative to its request for a 301(h) waiver from secondary treatment requirements – which also demonstrates the close hydrologic connection between the Peirce Island plant and Little Bay. The influence of the Peirce Island WWTP and associated CSOs on Little Harbor requires detailed and thorough consideration as part of this TMDL Study, and requires the imposition of Waste Load Allocations requiring those point-sources to reduce their discharges of bacteria. These facts further demonstrate the need for the plant to finally install higher levels of treatment than its current enhanced primary treatment, and for EPA and DES to deny Portsmouth's request for a Section 301(h) waiver from secondary treatment and impose more stringent controls through a new NPDES permit. *See* CLF's two sets of comments to the EPA urging denial of a Section 301(h) waiver, appended hereto.

No change. The July 2001 dye dispersion study prepared by EPA incorrectly referred to Back Channel as "Little Harbor". The study, in fact, contained very little information about water quality in Little Harbor. Most of the sampling was done in the lower Piscataqua River and Back Channel, which are outside of the study area for the Little Harbor TMDL. The April 2003 report for the City of Portsmouth contained some environmental sampling information for Little Harbor. However, the results did not indicate a strong linkage between the WWTF discharge and water quality in Little Harbor. The strongest linkage in the report was the following statement: "A specific 'event' at the plant, which allowed partially or untreated sewage to get into the river, would produce temporary high counts especially if this happened at the tidal stage when portions of the river flow go into the Back Channel and Little Harbor region." The DES Shellfish Program tracks discharge events at WWTFs. In the past six years since 2000, they have recorded six events at the Portsmouth WWTF. Therefore, the linkage between water quality in Little Harbor and discharges from the Portsmouth WWTF is not well established and, if there were a linkage, the effects would occur infrequently. The goal of the TMDL study is to quantify the major sources of bacteria to Little Harbor. Based on the discussion above, the Portsmouth WWTF is not considered a major source and therefore was not included in the study.

2. The Draft Study contains overly optimistic assumptions regarding discharge reductions. In determining the load reduction necessary to satisfy water quality standards, the Draft Study assumes there will be a 100 percent reduction in bacteria loads from illicit

connections and failing septic systems within MS4 urbanized areas, as well as a 100 percent reduction in loads from boat discharges. *See* Draft Study at 28, Table 14. We are concerned that these assumptions are unrealistically optimistic. Though we agree that the elimination of these illegal sources of pollution is of critical importance and must be pursued, loadings from these sources may nonetheless continue. Accordingly, to provide a margin of safety, more aggressive reductions (i.e. greater than 5%) and lower Waste Load Allocations must be required for MS4 stormwater discharges. Moreover, these Waste Load Allocations for MS4 stormwater discharges should be further broken down on a municipality-by-municipality basis, and the MS4 programs for the three relevant communities should be closely scrutinized and strengthened to ensure these more aggressive load reductions are achieved. CLF has expressed strong concern with the effectiveness of the Small-MS4 regulatory program. *See*, for example, CLF's attached comments on the City of Portsmouth's Notice of Intent for coverage under the Small MS4 General Permit. Unless and until these concerns are addressed, it is unrealistic to assume the reductions contemplated in the Draft Study.

No change.

Overboard boat discharges are a direct, undiluted source of untreated sewage to Little Harbor. DES recently established NH's coastal waters as a "No Discharge Area" for boat sewage. Therefore, in order to reflect the importance of removing overboard discharges and to be consistent with the new regulation, the allocation for boat discharges should remain as zero. For illicit discharges and failing septic systems, the load allocations for these sources on Table 14 already reflect the fact that some of these sources will remain active in the watershed. Please see the discussion on page 27 regarding the allocations for illicit discharges and failing septic systems in urbanized areas and other areas.

The TMDL already contains both explicit and implicit margins of safety. On page 29, the explicit margin of safety was applied, whereby 10% of the water quality standard was reserved. The study also made several conservative assumptions to create an implicit margin of safety. In particular, the watershed model did not assume any attenuation of bacteria during fate and transport and the more stringent water quality standard was chosen as the TMDL target.

The bacteria loads were predicted by a watershed model. The municipal boundaries do not correspond to the watershed boundaries. It would violate the assumptions of the model to run the model using the municipal boundaries. A rough approximation of the municipality-by-municipality loads can be made from the percent of each watershed in each town. The majority of the Sagamore Creek watershed is in Portsmouth and the majority of the Berrys Brook and Witch Creek watershed is in Rye. All of the New Castle watershed is in New Castle. The bacteria loads from each of the watersheds are provided in Table 12 and Figure 8.

3. The DES and MS4 Permittee Action Items should be further supplemented. As discussed above, CLF has raised significant concerns with the effectiveness of the Small-MS4 regulatory program. As a result of these concerns – as contained in the attached comments regarding Portsmouth's program, as well as other comments relative to the Town of Greenland and NH Department of Transportation – DES approached CLF to discuss a collaborative project involving DES, CLF and at least one Seacoast community. These discussions evolved into a grant proposal submitted by DES to EPA seeking funding for DES, the City of Portsmouth, and CLF to work together to address certain concerns raised by CLF and, in so doing, to develop a model for replication by other communities. Though the EPA did not fund this proposal, it is my understanding that DES remains interested in pursuing such an effort, and that it is currently exploring funding opportunities. CLF believes such an effort would be very valuable, and should be included among the DES and MS4 Permittee Action Items listed on pages 30 and 31 of the Draft Study.

No change. EPA funding for the proposal was not obtained. With the funding that is currently available, DES and the City of Portsmouth are developing a stormwater master plan. This plan will address some of the concerns raised by CLF. The project will cover all areas of the City, not just the Little Harbor watersheds. Therefore, it is not appropriate to add this project as an action item to the implementation plan for the Little Harbor TMDL.

On April 10, 2006 and May 8, 2006 EPA provided DES with comments on the third draft of the TMDL document. The EPA comments are listed below, followed by the DES response in italics.

1. All EPA regions have been asked to only approve TMDLs that include daily loads. This can be in addition to other forms of calculations such as percent reduction.

Agree. The TMDL and allocations in Table 14 will be changed accordingly. Annual loads will be divided by 365 days per year to calculate daily loads.

2. We are uncomfortable with the load allocation for illicit connections and failing septic systems outside of the MS4 area. Our concern is that it could be misconstrued as an authorization for illegal discharges or a reason for communities not to address this type of problem. Justification for this, as stated on page 27 of the TMDL report is as follows: "DES recognizes that illicit connections and failing septic systems are illegal regardless of whether they occur in the urbanized area or not and DES encourages all communities to take a proactive role in identifying and removing such sources. However, it is unrealistic to expect that many illicit connections and failing septic systems will be found in areas where municipalities are not required by a permit to inspect their stormwater systems to the degree required by MS4 permittees." We suggest that the load allocations be set to zero for illicit connections and failing septic systems in the non MS4 areas (as in the MS4 areas) or that the load allocation be qualified as temporary by eliminating the second (underlined sentence) and replacing it by something to the effect that "this wasteload allocation is temporary until these sources are eliminated after which this wasteload will be folded into the margin of safety." It is unlikely that EPA could approve a TMDL that appears to allow illegal discharges. In addition, Portsmouth has already said in their comments they intend to address illicit connections over the entire City.

Agree. DES will change the allocations for illicit discharges and failing septic systems to zero for both the MS4 and non-MS4 areas. All other allocations in the TMDL will remain the same. An explicit margin of safety of 12.9 billion organisms per day will be added to balance the TMDL equation.

DES responded to a comment about this issue on the second draft of the TMDL (October 2005) from the Conservation Law Foundation (see page 37 of this report). By making the change requested by EPA, the DES response to CLF's comment is no longer accurate. Nevertheless, the intent of CLF's comment is addressed in the final version of the document. DES moved the allocations for illicit discharges and failing septic systems in non-MS4 areas to an explicit margin of safety. None of the other allocations were increased. Therefore, the total allocation to sources was reduced as a result of the change. The explicit margin of safety should be sufficient to account for any illicit discharges or failing septic systems which are not found.

3) The municipalities of Portsmouth, New Castle, and Rye are covered under the Phase II general permit for stormwater, as noted in the TMDL report. We did not see mention of the New Hampshire Department of Transportation. Are there any State roadways in the MS4 area that contribute to water quality impairments in Little Harbor?

No change. NH DOT roadways cover a negligible area of the Little Harbor watershed. The catch basins on these roadways are expected to be relatively clean because there is not much pedestrian traffic along these roads and litter is minimal. Worst case predictions of bacteria loads from these catch basins amount to 0.05 billion organisms per day, which is less than one hundredth of a percent of the TMDL.

4) The highest concentrations of bacteria have been documented in the Witch Creek/Berrys Brook assessment unit. The response to comments says the implementation plan contains tasks to better characterize conditions so that a TMDL can be completed in the future. Since it is likely to come up at our meeting, what are the key tasks and when is completion of this TMDL expected?

No change. DES is supporting, with 319 funds, microbial source tracking work in Berrys Brook as a way to identify bacteria sources. The schedule for completing a TMDL for bacteria in Berrys Brook will depend on resources and will be negotiated with EPA as part of the TMDL prioritization process.

On May 16, 2006, DES met with municipalities and other organizations listed in the implementation plan. The meeting had been requested by the City of Portsmouth on comments dated December 10, 2004 and November 30, 2005.

The attendees are the meeting were:
Phil Trowbridge, NH DES
Gregg Comstock, NH DES
Al Basile, EPA
Natalie Landry, NH DES
Jeff Gardner, Rye Conservation Commission
Pat Kelley, Wentworth Marina
Peter Britz, City of Portsmouth
Silke Psula, City of Portsmouth
Kristie Rabasca, Edwards and Kelcey
Thelma Murphy, EPA
David Allen, City of Portsmouth
Peter Rice, City of Portsmouth

The following comments on the third draft of the TMDL document were provided during the meeting.

First bullet on page 2 of the executive summary is confusing and should be re-worded.

> *Agree. The bullet will be reworded to more clearly state the changes to the municipal stormwater management programs that DES expects as part of the implementation plan.*

The modeled loads, numeric allocations and TMDL are not accurate and should be considered approximate. The model should be updated and improved.

> *No change. DES agrees that the modeled values are approximate. However, EPA requires that TMDLs set numeric allocations.*

Detecting failing septic systems is not the responsibility of the municipalities and is not part of the MS4 permit. The landowner has the responsibility for detecting and fixing failing septic systems. DES and municipalities can confirm failing septic systems and provide advice for fixing them. Failing septic systems should be considered non point sources and not be part of the MS4 permittee action items.

> *Agree. DES will move all of the loads from failing septic systems to the non point source category. References to failing septic systems in DES action item #1 and MS4 permittee action item #5 will be removed. DES will add a new action item for DES to work collaboratively with municipalities and others on septic system education and outreach.*

Action item #3 for MS4 permittees is confusing and redundant with action item #5.

> *Agree. This action item will be deleted.*

Efforts to reduce overboard discharges from boats have focused on education and making pump outs convenient, not enforcement.

> *No change. The establishment of the NH coast as a No Discharge Area has provided DES with additional enforcement powers.*

The National Coastal Assessment is ending and should not be relied upon for long-term monitoring for implementation.

> *Agreed. DES will leave the enterococci monitoring at station NH-0023A in Little Harbor as part of the implementation plan but will remove the reference to the National Coastal Assessment.*

8. References

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DES (2004a) Annual Shellfish Growing Area Update for the Little Harbor and Back Channel, New Hampshire. N.H. Department of Environmental Services, Watershed Management Bureau, Concord, NH. February 2004.

DES (2004b) 2004 Section 305b and 303d Consolidated Assessment and Listing Methodology and Comprehensive Monitoring Strategy. NHDES-R-WD-02-11. N.H. Department of Environmental Services, Watershed Management Bureau, Concord, NH. March 2004.

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DES (2003b) Total Maximum Daily Load Study for Hampton/Seabrook Harbor. N.H. Department of Environmental Services, Watershed Management Bureau, Concord, NH. September 2003.

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EPA (2002) Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on those WLAs. Memorandum from Robert Wayland III, US Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans, and Watersheds, Washington, DC. November 22, 2002.

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Jones SH and Langan R (1996) Assessment of Clam Resources and Sanitary Quality of the Shellfish Growing Waters in Witch Creek, Seavey Creek, and Little Harbor. A final report to the NH Coastal Program, prepared by the University of New Hampshire, Durham, NH. July 1996.

APPENDIX A

Little Harbor TMDL Wet-Weather Sampling Program Summary

LITTLE HARBOR TMDL WET-WEATHER SAMPLING PROGRAM SUMMARY

Project Goals and Objectives

In order to identify the sources of bacteria to the harbor, the DES Shellfish Program conducted a sanitary survey of Little Harbor and Back Channel in accordance with National Shellfish Sanitation Program (NSSP) guidelines (DES, 2001). Between 1999 and 2001, all of the properties along the shoreline of Little Harbor and Back Channel were surveyed for potential sources of bacteria. One hundred thirty nine potential sources were found. Most of the sources were sampled for bacteria during dry weather conditions. Only a few of the large sources were monitored after rainfall events. Therefore, despite the extensive work completed for the Little Harbor Sanitary Survey, there is still incomplete information on the loading from the pollution sources during wet weather, which is the critical time period for achieving the water quality standards. One of the recommendations from the study was:

"Sampling of potential stormwater/wet weather sources of pollution identified in the shoreline survey should be pursued. Estimations of discharge from each source should be made concurrently with the bacterial sampling. Such data will be invaluable to efforts to identify and eliminate the sources of pollution that make the rainfall condition on harvesting necessary."

The goal of the Little Harbor TMDL Wet-Weather Sampling Program was to implement this recommendation.

This study measured bacteria concentrations and flow from the bacteria sources around the harbor during wet-weather conditions. DES Water Quality Section will use the results of this study (as well as other information) for the "Source Assessment" section of a bacteria Total Maximum Daily Load (TMDL) report for Little Harbor. The results of the study will also be used by the DES Shellfish Program and DES Watershed Assistance Section to determine how best to allocate restoration funds.

Methods

Over 100 pipes, streams, creeks, and conveyances of stormwater have been identified around Little Harbor and Back Channel by the DES Shellfish Program (DES, 2001). During 2003, DES selected the 21 stormwater sources most likely to be large contributors of bacteria based on the size of the pipe and the fecal coliform concentrations that had been measured by the DES Shellfish Program (DES, 2003). These pipes were monitored for bacteria loads during four storms on 7/11/03, 8/1/03, 9/2/03, and 9/4/03 (not all of the pipes were monitored on all four storms). In 2004, the stormwater sampling was continued at LHPS003, a 36 inch MS4 pipe that discharges directly to the Little Harbor assessment unit. Stormwater from LHPS003 was sampled on 4/13/04, 4/14/04, and 6/29/04.

At the each station, water samples were collected for fecal coliforms and the flow was either measured or estimated. Field and laboratory methods for the study are summarized in the Quality Assurance Project Plan (DES, 2003).

The sampling stations for the Little Harbor TMDL are shown in Figures A1 and A2.

Figure A1: Stormwater sampling stations for the Little Harbor TMDL Study

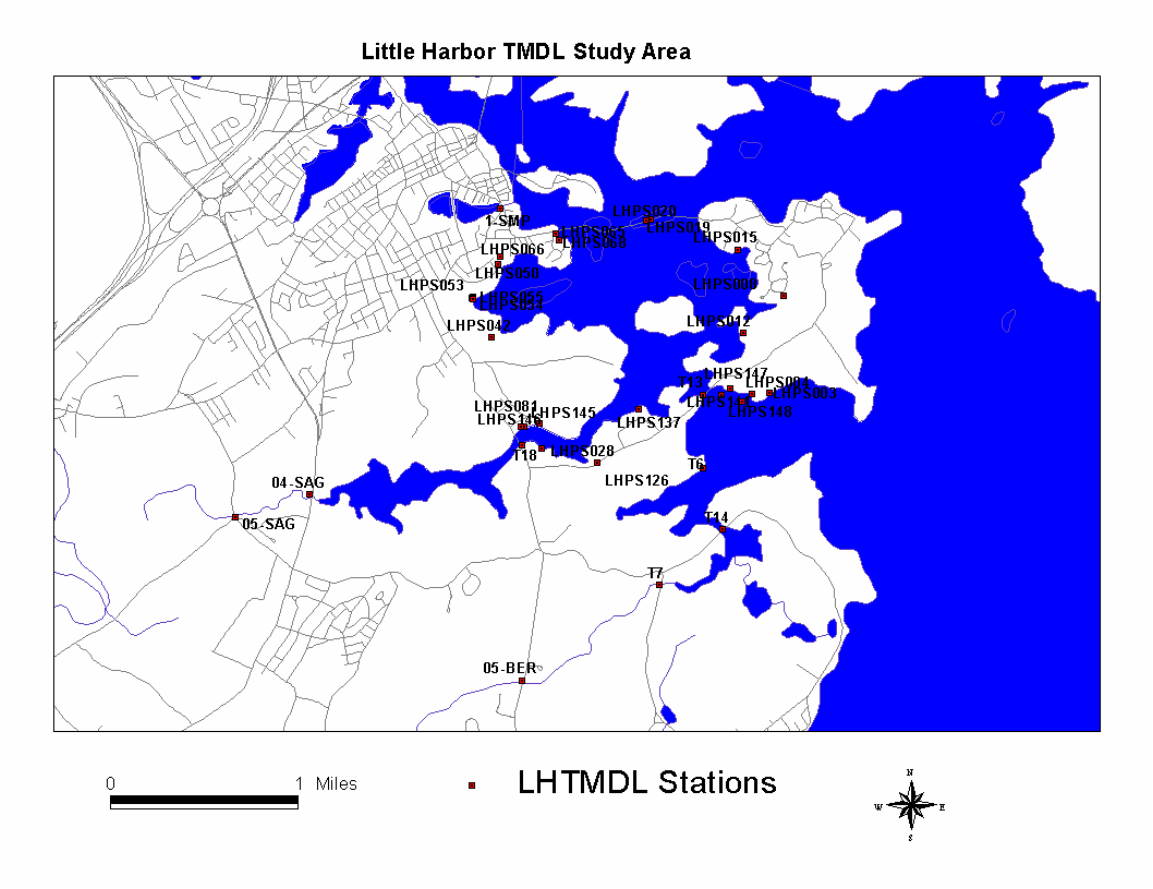
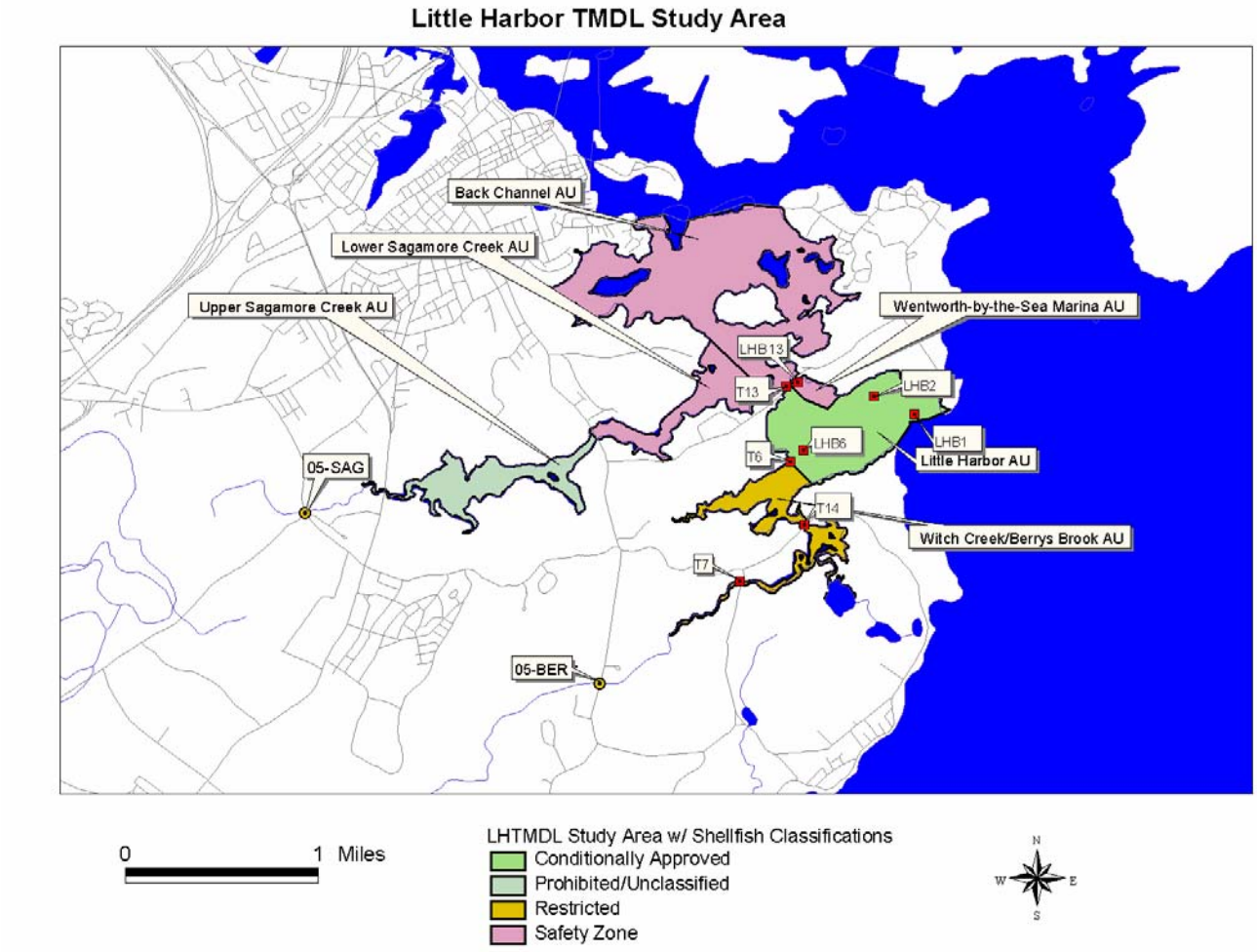


Figure A2: Ambient sampling stations for the Little Harbor TMDL Study



Flow measurements at two stations, 05-BER and 05-SAG, are based on a combination of direct measurements and extrapolation from other streamgages. The assumptions used to estimate the flow for each day of the study are listed below.

- For 05-BER, the Berrys Brook gage was not functioning reliably (beaver problems) on 3 of the 5 LHTMDL sampling dates at this station. For these dates, the daily streamflow from Oyster River transposed has been used. For the other two dates (7/11/03, 6/29/04), the daily streamflow estimate for Berrys Brook has been used.
- For 05-SAG, field crews measured the flow directly on 2 of the 5 LHTMDL sampling dates. On 9/4/03, the flow was measured at 0.6 cfs, which is higher than the daily average flow of 0.14 cfs that would be predicted by area transposition from the flow in the Oyster River. The Berrys Brook gage was not functioning reliably on this date. On 6/29/04, the flow was measured at 0.37 cfs. The gage in the Oyster River did not record a value on this date. However, the Berrys Brook gage was functioning and, based on area transposition, would predict a daily average flow of 0.13 cfs at 05-SAG. Therefore, in both cases, the instantaneous flow reading was higher than the

predicted daily average flow (as would be expected). The measured flows will be used for these two dates. The predicted daily flows from the Oyster River gage will be used to estimate the flows on the three other days.

In order to calculate loadings from all of the sources, several assumptions were needed. If the fecal coliform concentrations was reported as "Too Numerous to Count", the result was assigned a value of 20,000 cts/100ml for stormwater pipes and 2,000 cts/100ml for instream sites. If the flow was recorded as "Too Low To Measure", the result was assigned a value of 0.002 cfs (1 gallon per minute), which is the assumption the DES Shellfish Program makes for low flows. The lowest recorded flow during the study was 0.001 cfs, so this assumption seems reasonable.

Results and Discussion

The rainfall history for each of the storms is shown in Table A1.

Table A1: Storm history for DES stormwater sampling in 2003 and 2004

	Storm Precipitation		Sampling	Precipitation Prior and During Sampling		
Date	Total (in)	Duration	Duration	Total (in)	Duration	Total for Past 48 hrs
7/11/2003	0.66	06:00 to 17:00	11:50 to 14:25	0.65	06:00 to 14:00	0.72
8/1/2003	1.16	08:00 to 21:00	09:45 to 11:46	0.99	08:00 to 11:00	1
9/2/2003	0.22	01:00 to 12:00	10:33 to 12:00	0.22	01:00 to 12:00	0.22
9/4/2003	0.65	9/3/03 23:00 to 10:00	09:39 to 11:15	0.65	9/3/03 23:00 to 10:00	0.87
9/18/2003	0.00	---	10:49 to 11:19	0.00	---	0.83
9/19/2003	0.15	14:00 to 16:00	09:21 to 10:25	0.00	---	0
4/13/2004	0.36	01:00 to 13:00	08:30 to 13:00	0.36	01:00 to 13:00	0.36
4/14/2004	1.01	4/13/04 16:00 to 02:00	09:20 to 11:20	0.99	4/13/04 16:00 to 02:00	1.35
6/29/2004	0.21	03:00 to 08:00	11:30 to 12:55	0.21	03:00 to 08:00	0.21

Data Source: Seabrook Station precipitation records

All of the data passed quality assurance review and are considered suitable for the Little Harbor TMDL study. A summary of the results for the stormwater sources is presented in Table A2. The quality assurance summaries as well as the raw data summaries for each station are attached.

Table A2: Average fecal coliform concentrations and loads from storm drain sources in 2003 and 2004

Summary of Stormwater FC Concentrations

Average of TOTAL FECAL COLIFORM	
Stationid	Total
1-SMP	108
LHPS003	690
LHPS004	55
LHPS008	253
LHPS015	NA
LHPS019	NA
LHPS020	NA
LHPS028	5,933
LHPS042	4,380
LHPS050	NA
LHPS053	2,000
LHPS054	20,000
LHPS055	6,392
LHPS065	NA
LHPS066	NA
LHPS068	20,000
LHPS081	13,367
LHPS126	806
LHPS137	20,000
LHPS145	6,575
LHPS146	16,800
MEAN	7,824
MEDIAN	5,933
MAXIMUM	20,000

**FC concentrations in cts/100ml*

Summary of Stormwater FC Loads

Average of FC LOAD		
Stationid	Total	%of Total
1-SMP	NA	NA
LHPS003	0.99	0.4%
LHPS004	0.00	0.0%
LHPS008	7.67	3.3%
LHPS015	0.00	0.0%
LHPS019	0.00	0.0%
LHPS020	0.00	0.0%
LHPS028	0.49	0.2%
LHPS042	53.71	23.3%
LHPS050	0.00	0.0%
LHPS053	NA	NA
LHPS054	73.41	31.8%
LHPS055	73.48	31.8%
LHPS065	0.00	0.0%
LHPS066	0.00	0.0%
LHPS068	0.49	0.2%
LHPS081	1.71	0.7%
LHPS126	15.72	6.8%
LHPS137	0.00	0.0%
LHPS145	2.58	1.1%
LHPS146	0.51	0.2%
MEAN	12.15	
MEDIAN	0.49	
MAXIMUM	73.48	
TOTAL	230.76	

**FC loads in billion org/day*

STATE OF NEW HAMPSHIRE
Inter-Department Communication

DATE September 10, 2004

FROM Phil Trowbridge
Watershed Management Bureau

AT (OFFICE) Water Division,

SUBJECT QA/QC Review: Tidal Bacteria TMDL Program

TO Vince Perelli

This memorandum summarizes the QA activities conducted under the Tidal Bacteria TMDL Program during 2003 and 2004. Only one project was completed during this time: the Little Harbor Bacteria TMDL.

Summary of QA/QC Objectives
The objectives described in the approved QAPP, dated April 25, 2003, and amended on June 6, 2003 and August 4, 2003, were met. These include the proper training of the field technicians, proper handling of water samples, proper collection of field data, the review of data relative to the acceptance criteria documented in the QAPP, and input of the data to appropriate databases. All water sampling was conducted in accordance with the approved QAPP and the associated SOPs. Each field measurement and laboratory result was reviewed by the Project Manager to determine data quality.

Description of Training Activities
The Program Manager instructed the Field Team Leaders on proper use of the water quality sampling and flow measurement equipment according to the approved SOPs on 5/20/03. This instruction was given in the field at the project site.

Conformance to QAPP Requirements/Descriptions of Deviations
All inconsistencies with the approved QAPP during the 2002 monitoring season are shown in Table A1.

Limitations of the Data
The data were collected from storm drains during rainstorm events. Therefore, these data do not represent ambient or typical conditions.

Documentation of Usable Data Versus Actual Data Collected

The Program Manager reviewed all results from field sampling and laboratory analysis. Comments relative to the field data were written directly on the field data sheets. **All data are acceptable and will be used in the TMDL study.**

Table A1. QAPP inconsistencies during the 2003-2004 Little Harbor TMDL

QAPP Section	Description	QAPP/SOP Inconsistency
A4	Project Task/Organization	The QA officer is not supposed to also participate in the field sampling. However, due to a lack of staff to help with the sampling, the QA Officer participated in both rounds of sampling. ***This non-conformity is not expected to affect the quality of the data.***
A7	Quality Objectives and Criteria - Precision	Four of 14 sets of duplicate stormwater samples had RPD values for fecal coliforms outside the DQO. These samples were collected on 9/4/03, 9/18/03, 9/19/03, and 4/14/05. In all cases, the fecal coliform concentrations in the samples was low so that absolute difference between the samples was small, even though the relative difference was large. The field teams did not report any nonconformities with SOPs for these samples. ***Therefore, this nonconformity is not expected to affect the quality of the data.*** Two of five sets of duplicate stormwater samples had RPD values for flow outside the DQO. These samples were collected on 7/11/03 and 9/4/03. In both cases, the flow was low so that absolute difference between the samples was small, even though the relative difference was large. The field teams did not report any nonconformities with SOPs for these samples. ***Therefore, this nonconformity is not expected to affect the quality of the data.*** One of four sets of duplicate stormwater samples had RPD values for *E. coli* and enterococcus outside the DQO. These samples were collected on 6/29/04. The concentrations of *E. coli* and enterococcus were low so that absolute difference between the samples was small, even though the relative difference was large. The field teams did not report any nonconformities with SOPs for these samples. ***Therefore, this nonconformity is not expected to affect the quality of the data.*** **All of the field duplicates collected for this study are shown in Table A2 and Table A3.**
B1	Sampling Process Design	Sections for "Phase I Storm Selection" and "Phase II Storm Selection" required that the storms sampled for the TMDL have >0.25 inches of rainfall per 24 hours prior to the sampling. For the Phase I sampling, Table A1 of the TMDL showed that 3 of the 4 storms had >0.25 inches of rainfall. The forth storm had 0.22 inches of rainfall. Given that this forth storm was close to the specified amount, data from this storm was included in the TMDL. For the Phase II sampling, Table A1 of the TMDL showed that 2 of the 3 storms had >0.25 inches of rainfall. The third storm had 0.21 inches of rainfall. Given that this third storm was close to the specified amount, data from this storm was included in the TMDL. ***This nonconformity is not expected to affect the quality of the data.*** Field teams collected data or made observations at all of the sampling stations except for LHPS012 and T16. Construction around the Wentworth Hotel had interfered with access to LHPS012. Data from T16 was not needed for the TMDL model. ***Therefore, this nonconformity is not expected to affect the quality of the data.***

QAPP Section	Description	QAPP/SOP Inconsistency
		The June 6, 2003 addendum to the QAPP set a goal for field duplicate samples of bacteria and flow to occur every 10th sample (10%). Over the course of the study, field duplicates were taken at the following rate: fecal coliforms (9%), flow (9%), *E. coli* (12%), enterococcus (12%). Therefore, the duplicate rate for fecal coliforms and flow was slightly below the target. ***This non-conformity is not expected to affect the quality of the data.***

Table A2: Summary of quality assurance samples for the Little Harbor TMDL Study

Summary of Quality Assurance Samples for Accuracy and Precision

Parameter	Number of Samples	Number of Field Duplicates	Ratio of Duplicates to Samples	Duplicates that Pass the DQO	Percent Duplicates Passing
Total Fecal Coliform	154	14	9%	10	71%
Flow	54	5	9%	3	60%
Enterococcus	33	4	12%	3	75%
Escherichia coli	33	4	12%	3	75%

Notes/Comments

For all parameters, the duplicates that failed the DQO test had low values so that small absolute differences resulted in large percent differences. These small differences do not affect the accuracy of the loading estimates in the TMDL. Therefore, all of the data collected for this study are useable. Specific information for each parameter is listed below.

For total fecal coliforms, the absolute difference for duplicates that failed the DQO was 5-30 cts/100ml, which is small compared to the average FC concentration for all the samples, 2209 cts/100ml.

For flow, the absolute difference for duplicates that failed the DQO was 0.001-0.002 cfs, which was small compared to the average flow for all the samples, 0.53 cfs.

For enterococcus, the absolute difference for duplicates that failed the DQO was 10 cts/100ml, which was small compared to the average Enterococcus concentration for all the samples, 91 cts/100ml.

For E.coli, the absolute difference for duplicates that failed the DQO was 20 cts/100ml, which was small compared to the average E.coli concentration for all the samples, 84 cts/100ml.

Summary of Quality Assurance for Completeness

Period	DQO	Data Collected
Phase I	3 storms	4 storms
Phase II	2 storms	3 storms

Notes/Comments

The goal was to collecte data during three storms for Phase I and two storms for Phase II. This goal was surpassed. Therefore, the DQO for completeness has been met.

Table A3: Quality assurance samples collected for the Little Harbor TMDL Study

Stationid	Category	Date	Time	Wshedparmname	Result	Qual	Units	Difference	RPD	DQO	Meets DQO?	Comments
T13A	FIELD DUPLICATE	04/14/2004	10:20:00	ENTEROCOCCUS	10	<	CTS/100ML	0	0%	40%	YES	
T13A	ROUTINE SAMPLE	04/14/2004	10:20:00	ENTEROCOCCUS	10		CTS/100ML					
T13A	ROUTINE SAMPLE	06/29/2004	12:40:00	ENTEROCOCCUS	10	<	CTS/100ML	10	67%	40%	NO	Acceptable because absolute difference is small
T13A	FIELD DUPLICATE	06/29/2004	12:40:00	ENTEROCOCCUS	20		CTS/100ML					
T14	FIELD DUPLICATE	04/13/2004	08:30:00	ENTEROCOCCUS	10	<	CTS/100ML	0	0%	40%	YES	
T14	ROUTINE SAMPLE	04/13/2004	08:30:00	ENTEROCOCCUS	10	<	CTS/100ML					
T14	ROUTINE SAMPLE	04/14/2004	09:20:00	ENTEROCOCCUS	20		CTS/100ML	10	40%	40%	YES	
T14	FIELD DUPLICATE	04/14/2004	09:20:00	ENTEROCOCCUS	30		CTS/100ML					
T13A	FIELD DUPLICATE	04/14/2004	10:20:00	ESCHERICHIA COLI	10	<	CTS/100ML	0	0%	40%	YES	
T13A	ROUTINE SAMPLE	04/14/2004	10:20:00	ESCHERICHIA COLI	10		CTS/100ML					
T13A	ROUTINE SAMPLE	06/29/2004	12:40:00	ESCHERICHIA COLI	10		CTS/100ML	20	100%	40%	NO	Acceptable because absolute difference is small
T13A	FIELD DUPLICATE	06/29/2004	12:40:00	ESCHERICHIA COLI	30		CTS/100ML					
T14	FIELD DUPLICATE	04/13/2004	08:30:00	ESCHERICHIA COLI	10	<	CTS/100ML	0	0%	40%	YES	
T14	ROUTINE SAMPLE	04/13/2004	08:30:00	ESCHERICHIA COLI	10	<	CTS/100ML					
T14	FIELD DUPLICATE	04/14/2004	09:20:00	ESCHERICHIA COLI	10	<	CTS/100ML	0	0%	40%	YES	
T14	ROUTINE SAMPLE	04/14/2004	09:20:00	ESCHERICHIA COLI	10	<	CTS/100ML					
LHPS008	FIELD DUPLICATE	09/04/2003	11:15:00	FLOW	0.55		CFS	0.01	2%	20%	YES	
LHPS008	ROUTINE SAMPLE	09/04/2003	11:15:00	FLOW	0.56		CFS					
LHPS042	ROUTINE SAMPLE	08/01/2003	11:45:00	FLOW	0.54		CFS	0.09	18%	20%	YES	
LHPS042	FIELD DUPLICATE	08/01/2003	11:46:00	FLOW	0.45		CFS					
LHPS042	FIELD DUPLICATE	09/02/2003	11:15:00	FLOW	0.002	<	CFS	0	0%	20%	YES	
LHPS042	ROUTINE SAMPLE	09/02/2003	11:15:00	FLOW	0.002	<	CFS					
LHPS081	ROUTINE SAMPLE	07/11/2003	13:08:00	FLOW	0.005		CFS	0.001	22%	20%	NO	Acceptable because absolute difference is small
LHPS081	FIELD DUPLICATE	07/11/2003	13:33:00	FLOW	0.004		CFS					
LHPS145	FIELD DUPLICATE	09/04/2003	10:15:00	FLOW	0.008		CFS	0.002	22%	20%	NO	Acceptable because absolute difference is small
LHPS145	ROUTINE SAMPLE	09/04/2003	10:15:00	FLOW	0.01		CFS					
LHB18	FIELD DUPLICATE	09/19/2003	09:35:00	TOTAL FECAL COLIFORM	10	<	CTS/100ML	0	0%	40%	YES	
LHB18	ROUTINE SAMPLE	09/19/2003	09:35:00	TOTAL FECAL COLIFORM	10	<	CTS/100ML					
LHB19	FIELD DUPLICATE	09/04/2003	09:50:00	TOTAL FECAL COLIFORM	10		CTS/100ML	10	67%	40%	NO	Acceptable because absolute difference is small
LHB19	ROUTINE SAMPLE	09/04/2003	09:50:00	TOTAL FECAL COLIFORM	20		CTS/100ML					
LHB19	ROUTINE SAMPLE	09/18/2003	10:55:00	TOTAL FECAL COLIFORM	10	<	CTS/100ML	5	67%	40%	NO	Acceptable because absolute difference is small
LHB19	FIELD DUPLICATE	09/18/2003	10:56:00	TOTAL FECAL COLIFORM	5	<	CTS/100ML					
LHB19	ROUTINE SAMPLE	09/19/2003	09:30:00	TOTAL FECAL COLIFORM	5	<	CTS/100ML	5	67%	40%	NO	Acceptable because absolute difference is small
LHB19	FIELD DUPLICATE	09/19/2003	09:30:00	TOTAL FECAL COLIFORM	10	<	CTS/100ML					
LHPS008	ROUTINE SAMPLE	09/04/2003	11:15:00	TOTAL FECAL COLIFORM	560		CTS/100ML	90	15%	60%	YES	
LHPS008	FIELD DUPLICATE	09/04/2003	11:15:00	TOTAL FECAL COLIFORM	650		CTS/100ML					
LHPS042	ROUTINE SAMPLE	08/01/2003	11:45:00	TOTAL FECAL COLIFORM	12100		CTS/100ML	1700	15%	60%	YES	
LHPS042	FIELD DUPLICATE	08/01/2003	11:46:00	TOTAL FECAL COLIFORM	10400		CTS/100ML					
LHPS042	FIELD DUPLICATE	09/02/2003	11:15:00	TOTAL FECAL COLIFORM	7600		CTS/100ML	0	0%	60%	YES	
LHPS042	ROUTINE SAMPLE	09/02/2003	11:15:00	TOTAL FECAL COLIFORM	7600		CTS/100ML					
LHPS081	ROUTINE SAMPLE	07/11/2003	13:08:00	TOTAL FECAL COLIFORM	20000	>	CTS/100ML	0	0%	60%	YES	
LHPS081	FIELD DUPLICATE	07/11/2003	13:33:00	TOTAL FECAL COLIFORM	20000	>	CTS/100ML					
LHPS145	ROUTINE SAMPLE	09/04/2003	10:15:00	TOTAL FECAL COLIFORM	1100		CTS/100ML	900	58%	60%	YES	
LHPS145	FIELD DUPLICATE	09/04/2003	10:15:00	TOTAL FECAL COLIFORM	2000		CTS/100ML					
T13A	ROUTINE SAMPLE	07/11/2003	14:22:00	TOTAL FECAL COLIFORM	60		CTS/100ML	10	18%	40%	YES	
T13A	FIELD DUPLICATE	07/11/2003	14:25:00	TOTAL FECAL COLIFORM	50		CTS/100ML					
T13A	ROUTINE SAMPLE	04/14/2004	10:20:00	TOTAL FECAL COLIFORM	20		CTS/100ML	10	40%	40%	YES	
T13A	FIELD DUPLICATE	04/14/2004	10:20:00	TOTAL FECAL COLIFORM	30		CTS/100ML					
T13A	FIELD DUPLICATE	06/29/2004	12:40:00	TOTAL FECAL COLIFORM	10		CTS/100ML	0	0%	40%	YES	
T13A	ROUTINE SAMPLE	06/29/2004	12:40:00	TOTAL FECAL COLIFORM	10		CTS/100ML					
T14	FIELD DUPLICATE	04/13/2004	08:30:00	TOTAL FECAL COLIFORM	10	<	CTS/100ML	0	0%	40%	YES	
T14	ROUTINE SAMPLE	04/13/2004	08:30:00	TOTAL FECAL COLIFORM	10		CTS/100ML					
T14	FIELD DUPLICATE	04/14/2004	09:20:00	TOTAL FECAL COLIFORM	10	<	CTS/100ML	30	120%	40%	NO	Acceptable because absolute difference is small
T14	ROUTINE SAMPLE	04/14/2004	09:20:00	TOTAL FECAL COLIFORM	40		CTS/100ML					

Project Quality Assurance Report for the Little Harbor Bacteria TMDL Study

Prepared by Peg Foss, TMDL Coordinator, NHDES

September 30, 2004

The purpose of this Project Quality Assurance Report is to provide detailed information pertaining to the Little Harbor Bacteria TMDL project's compliance with the guidelines set forth in the Quality Assurance Project Plan dated April 25, 2003, and amended on June 6, 2003 and August 4, 2003 ("the QAPP"), approved by EPA on May 21, 2003. This Project Quality Assurance report will include a review of the non conformances identified by the Project Manager during the study and additional information and discussion regarding conformances with the QAPP in order to provide information on the quality of the data, conclusions drawn from the data, and the calculation of the TMDL.

The Little Harbor Bacteria TMDL Study was conducted under the supervision of Gregg Comstock, Supervisor, of the Water Quality Planning Section, Watershed Management Bureau, of the New Hampshire Department of Environmental Services ("NHDES"). The Project Manager for the study is Phil Trowbridge, NH Estuaries Project Coastal Scientist, NHDES. Section D2 of the QAPP outlines the responsibilities of the QA Officer in reference to the review, verification, validation, reconciliation and qualification of the data collected for this study.

The QAPP for this project includes a clearly identified project objective and background information to support the purpose of the study. The data quality and objectives were identified, specific information was provided regarding the training, documentation and record keeping for the project and the roles and responsible of all parties involved were described. The sampling design, analytical methods, quality control and data management and assessment are all discussed in great detail in the QAPP. Furthermore, supportive information such as site maps, project schedules and sampling summaries prepared by the Project Manager provide additional information and insight into the project.

A memorandum dated September 10, 2004, prepared by the Project Manager ("the memo") contains a review of all of the known non conformities found during the course of the monitoring work. Ultimately it is up to the Project Manager to decide whether or not to include data, collected which falls outside the parameters set forth in the QAPP, in any calculations, assumptions, predictions, or conclusions in the final TMDL Report. If any such suspect data is included, the Project Manager is required to clearly identify the suspect data and the resultant uncertainty associated with it's intended use. A detailed discussion of each known nonconformity and the decision regarding the inclusion or exclusion of data is itemized in Table A1 of the memo and the resultant impact to the project is discussed below.

1. Section A4, Project Task Organization: QA Officer's participation in field sampling.

Section A8 of the QAPP requires that all "Field Sampling Team Leaders" participate in a mandatory field training session which was held in the field at the project site on 5/20/2003. The QA Officer participated in the training session and was designated a Field Sampling Team Leader. The attendance sheet for the training session with the signatures of all attendees, including the QA Officer's is included at the end of this Quality Assurance Report. Since the QA Officer met the training requirement as outlined in the QAPP this nonconformity is not expected to affect the quality of the data.

2. Section A7, Quality Objectives and Criteria-Precision: Duplicate samples outside the precision criteria.

Table 3 in Section A7 of the QAPP details the precision criteria requirement for each parameter tested or sampled in the study. The Project Manager is responsible for preparation of the final report and has the ultimate decision authority over whether to accept or reject any data that falls outside any of the criteria set forth in the QAPP.

The Project Manager included four of 14 sets of duplicate stormwater samples that had RPD values for fecal coliforms outside the DQO. The Project Manager confirmed that the results were not due to sampling or laboratory error and accepted the results as accurate. The Project Manager determined that including the data would not adversely affect the quality of the data or the conclusions drawn from it. The rationale for this determination was, although the relative difference between the samples was large, because the concentrations of fecal coliforms in all of the samples was low, it rendered the absolute difference between the samples small.

The Project Manager included two of five sets of duplicate flow measurements that fell outside the DQO. The Project Manager confirmed that the results were not due to sampling error and accepted the results as accurate. The Project Manager determined that including the data would not adversely affect the quality of the data or the conclusions drawn from it. The rationale for this determination was, although the relative difference between the samples was large, the flow was very low, which rendered the absolute difference between the samples small.

The Project Manager included one of four sets duplicate stormwater samples that had RPD values for *E. coli* and enterococcus outside the DQO. The Project Manager confirmed that the results were not due to sampling or laboratory error and accepted the results as accurate. The Project Manager determined that including the data would not adversely affect the quality of the data or the conclusions drawn from it. The rationale for this determination was, although the relative difference between the samples was large, because the concentrations of fecal coliforms in all of the samples was low, it rendered the absolute difference between the samples small.

Additional Comments Regarding Section A7 of the QAPP: Completeness, Representativeness and Total Error for the Project

Completeness

The goal of Phase I wet weather monitoring was to identify all potential sources of bacteria loading close to the shellfish growing area in Little Harbor and determine which of the sources where the major contributors to the loading. This was successfully completed. The goal of Phase II wet weather monitoring was to conduct more intensive sampling, including Microbial Source Tracking ("MST") to determine the source of the bacteria. In Phase II, sampling was conducted on twenty one stormwater pipes during four storm events in Little Harbor in 2003 and sampling was continued in 2004 where one stormwater pipe was sampled during three storm events. According to the QAPP, phase two of the study proposed to collect samples during three storm events and considered sample collection during two storms sufficient to meet the criteria set forth for completeness. Therefore, since the major stormwater sources were identified and sampled and since seven storms were samples over a two year period the project met the criteria for completeness.

Representativeness

The goal of this study was to collect data that would be representative of the major sources of wet-weather bacteria loading in Little Harbor that effect the shellfish growing area. Sampling during Phase I and Phase II of the study was conducted during storm events, Phase I identified the major wet-weather sources, Phase II consisted of more intensive monitoring of the

major sources, including pre-storm, first flush and the decline of first flush concentrations as well as Microbial Source Tracking ("MST") in order to try to identify the source (ie; human, wildlife etc.) of the bacteria entering the harbor. Therefore, the samples are considered representative of major stormwater sources of bacteria. The samples taken from the Harbor were the same ones used by the DES Shellfish Program to assess growing areas and are the stations that will be used to make future decisions about shellfish growing areas, hence they are representative of harbor conditions. Therefore, the goal of collecting data representative of the major sources of wet-weather bacteria loading in the harbor was met. The additional effort to collect MST data in order to identify the sources of the bacteria should enhance the effectiveness of implementation plans geared towards reducing and/or eliminating those sources.

Total Error for the Project

Since the data quality objectives for all of the individual components of the project were met, then the data quality objective for the total error for the project has been met.

3. Section B1, Sampling Process Design: Prerequisite for storm selection not met for one storm in each sample phase, Samples not collected at one site, the goal for the percentage of field duplicate samples of bacteria and flow not met.

The prerequisite for storm selection for Phase I and Phase II wet weather sampling required 0.25 inches of rain in the 24 hour period prior to the sampling event. One of the four storms sampled in Phase I had 0.22 inches of rain in the 24 hour period prior to sampling and one of the three storms sampled in Phase two had 0.21 inches of rain in the 24 hour period prior to sampling. The Project Manager included the data collected from these two storm events because they were only slightly below the criteria set forth in the QAPP. The decision to sample during the two lower rainfall storms represents a very small deviation from the QAPP requirements and the inclusion of the data collected during those storms is not expected to affect the quality of the data or the calculation of the TMDL.

Samples were not collected from sampling stations LHPS012 due to access problems related to construction activities around the Wentworth Hotel. The Project Manager determined that data from Sample Site T16 and LHPS012 were not needed for the TMDL model. Therefore, this nonconformity is not expected to affect the quality of the data.

The approved QAPP set a goal for field duplicate samples of bacteria and flow at 10%. Review of the data by the Project Manager revealed that only 9% duplicates were performed for both fecal coliforms and flow. This represents a very small deviation from the criteria set forth in the QAPP it is not expected to affect the quality of the data.

Additional Comments Regarding Section A9 of the QAPP: Maintenance and Distribution of Documents and Records.

The maintenance and distribution of documents such as the QAPP, the Project Plan, Field Sampling Data Sheets, Chain of Custody Sheets, Laboratory Reports and the Draft Final Report was found to be in compliance with the criteria set forth in the QAPP. After the Public Comment Period is over and the Final Report is approved by EPA the Project Manager is required to archive the data. The QA Officer will follow up with the Project Manager to ensure this is done.

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

LITTLE HARBOR TOTAL MAXIMUM DAILY LOAD (TMDL) STUDY

TRAINING RECORD

Training Date: May 20, 2003

Location: Pease Tradeport, Portsmouth

Attendee	Signature	Date
Phil Trowbridge		5/20/03
Peg Foss		5/20/03
Chris Nash		5/20/03
Matt Wood		5-20-03
Natalie Landry		
Rob Livingston		5/20/03
Ken Edwardson		5/20/03

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: 05-BER **Station Name:** BERRYS BROOK AT SAGAMORE AVE BRIDGE

Town: RYE **Station Type 1:** RIVER/STREAM

Latitude: 43 2 11 **Longitude:** -70 44 56

Station Description:

UPSTREAM SIDE OF BRIDGE OVER BERRYS BROOK ON SAGAMORE AVENUE. FACING UPSTREAM, TAKE SAMPLE FROM THE RIGHT BANK (OPPOSITE SIDE FROM STREAM GAGE). RECORD WATER HEIGHT ON USGS GAGE INSTALLED ON BRIDGE.

Directions to Station:

TAKE ROUTE 1A FROM PORTSMOUTH TOWARD ODIORNE STATE PARK. AT FOYES CORNER, TURN RIGHT ONTO SAGAMORE AVENUE. GO 3/4 MILE UNTIL SAGAMORE AVENUE CROSSES BERRYS BROOK. PARK IN PULL-OUT ON RIGHT SIDE OF ROAD BEFORE THE BRIDGE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:10:00			1790	2.5
09/02/2003	11:35:00			1000	.51
09/04/2003	10:25:00			870	1.61
09/19/2003	10:00:00			220	2.3
06/10/2004	10:49:00	248			
06/29/2004	12:15:00	210	140	190	1.5

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: 05-SAG **Station Name:** SAGAMORE CREEK AT PEVERLY HILL RD

Town: PORTSMOUTH **Station Type 1:** RIVER/STREAM

Latitude: 43 2 57 **Longitude:** -70 46 43

Station Description:

TWO OR THREE CULVERTS PASS UNDER PEVERLY HILL ROAD. TAKE SAMPLE DOWNSTREAM OF THESE CULVERTS AT THE POINT WHERE THE FLOWS FROM ALL CULVERTS COMBINE TO FORM A NARROW STREAM. COLLECT SAMPLE FROM THE MIDDLE OF THE STREAM USING A SAMPLING POLE.

Directions to Station:

HEAD SOUTH ON ROUTE 1 IN PORTSMOUTH. GO RIGHT ONTO PEVERLY HILL ROAD. GO 1/4 MILE TO NEXT NTERSECTION. TURN RIGHT AND THEN TAKE IMMEDIATE LEFT INTO PARKING AREA FOR A GLASS BUSINESS. DRIVE TO END OF PARKING LOT. WALK ACROSS GRASS TO STREAM.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	11:50:00			420	.08
09/02/2003	11:55:00			1870	.04
09/04/2003	10:00:00			>2000	.6
09/19/2003	09:30:00			10	.2
06/10/2004	10:15:00	53			
06/29/2004	11:30:00	30	100	70	.37

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS126 **Station Name:**

Town: RYE **Station Type 1:** PIPE

Latitude: 43 3 10.86 **Longitude:** -70 44 26.88

Station Description:

14 INCH CULVERT THAT RUNS UNDER WENTWORTH ROAD. PIPE INDUNDATED AT FROM MID-TIDE TO HIGH TIDE.

Directions to Station:

FOLLOW WENTWORTH RD (RTE 1B) TOWARD NEWCASTLE. JUST PAST WITCH COVE MARINA AND BG'S BOAT HOUSE, THERE IS A NARROW COVE WITH A DIRT PULLOUT ON THE RIGHT (SOUTH) SIDE. PARK IN THE PULLOUT AND CROSS RD. PIPE IS LOCATED AT HEAD OF COVE. MARKED BY METAL STAKE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	13:58:00			>2000	.47
09/02/2003	10:35:00			100	FLOW BUT NOT POSSIBLE TO MEASURE
09/04/2003	10:45:00			1500	.23
09/19/2003	09:55:00			120	
09/19/2003	09:56:00			110	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS137 **Station Name:**

Town: RYE **Station Type 1:** PIPE

Latitude: 43 3 25.14 **Longitude:** -70 44 10.98

Station Description:

12 INCH CAST IRON PIPE BUILT IN BASE OF ROCK WALL.

Directions to Station:

TAKE ROUTE 1B TO HARBORVIEW DRIVE. WALK TO SHORELINE BETWEEN #23 AND #29 HARBORVIEW DRIVE. WALK TOWARD PIER ON #23'S LOT. PIPE IS LOCATED IN THE ROCK WALL LINING #23'S PROPERTY ON THE LEFT SIDE OF THE PIER NEAR THE MARSH GRASS.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	14:15:00			>20000	0
09/02/2003	10:45:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS042 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** RIVER/STREAM

Latitude: 43 3 45.42 **Longitude:** -70 45 5.76

Station Description:

SMALL STREAM THAT DRAINS EAST SIDE OF PORTSMOUTH. SAMPLE AT OUTLET OF 36 INCH CULVERT THAT PASSES UNDER CURRIER COVE ROAD. TAKE SAMPLE AND MEASURE FLOW FROM CASCADE OVER THE LIP OF THE CULVERT.

Directions to Station:

FOLLOW CURRIER COVE RD UNTIL YOU SEE AN ELECTRICAL BOX SURROUNDED BY CEDAR TREES ON THE RIGHT. THE UTILITY BOX IS AFTER A TAN COLONIAL HOUSE AND BEFORE THE END OF THE CUL-DE-SAC. WALK INTO BRUSH TO THE LEFT OF THE UTILITY BOX AND TURN RIGHT.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
08/01/2003	11:45:00			12100	.54
08/01/2003	11:46:00			10400	.45
09/02/2003	11:15:00			7600	FLOW BUT TOO LOW TO MEASURE
09/04/2003	10:45:00			2000	.018
09/19/2003	09:45:00			110	
09/19/2003	10:25:00			90	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS050 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 4 5.82 **Longitude:** -70 45 3.3

Station Description:

12 INCH METAL PIPE. STICKS OUT OF BANK BETWEEN TWO DOCKS AT THE END OF A LAWN. PIPE IS LOCATED CLOSE TO HIGH TIDE LINE. TAN BUILDINGS WITH CREAM TRIM.

Directions to Station:

PARK AT END OF RIDGES CT. WALK DOWN TO SHORE AND HEAD RIGHT (WEST) FOR 300 FEET. PASS LHPS066 AFTER 200 FEET. CONTINUE AROUND SHORELINE OF A SMALL COVE. THE PIPE IS LOCATED BETWEEN THE TWO DOCKS AT THE END OF THE LAWN. BRACKETT ROAD.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:40:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS055 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 3 56.1 **Longitude:** -70 45 12.66

Station Description:

16 INCH CONCRETE, SEGMENTED PIPE. LOCATED AT MID-TIDE LINE. HALF BURIED IN SEDIMENT. COVERED WITH SEAWEED. PIPE BROKEN AT END.

Directions to Station:

ENTER CEMETARY FROM SOUTH STREET. GO STRAIGHT THEN LEFT FOLLOWING MAIN PATH. PARK AT TURN AROUND LOOP. WALK NORTH ACROSS CEMETARY TOWARD LH SCHOOL. PASS THROUGH BUSHES NEAR "CLARK" GRAVE. WALK 100 FT ACROSS MARSH. PIPE IS NEAR OLD TIRE IN MUD.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	13:30:00			TNTC	.26
09/02/2003	10:33:00			600	FLOW BUT NOT POSSIBLE TO MEASURE
09/04/2003	11:00:00			11200	.072
09/19/2003	10:10:00			70	
09/19/2003	10:15:00			90	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS065 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 4 13.8 **Longitude:** -70 44 41.8

Station Description:

12 INCH CONCRETE PIPE SET INTO A ROCK WALL AND SURROUNDED BY ROSE BUSHES. PIPE IS HALF FULL OF SEDIMENT. PIPE IS LOCATED AT HIGH TIDE LINE. PIPE JUST DRAINS ONE CATCH BASIN ON PLEASANT POINT ROAD.

Directions to Station:

PARK ACROSS FROM 4 PLEASANT POINT DRIVE NEXT TO WOODEN GUARD RAIL. HOP GUARD RAIL AND DOWN SMALL ROCK RETAINING WALL. THE PIPE IS SET AT THE BOTTOM OF THE WALL DIRECTLY ACROSS FROM CATCH BASIN IN FRONT OF 4 PLEASANT POINT DRIVE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:00:00				0
09/02/2003	11:45:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS066 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 4 7.74 **Longitude:** -70 45 2.46

Station Description:

10 INCH GREEN PVC PIPE SET INTO THE BASE OF A BERM. THE PIPE IS HALF FULL OF SEDIMENT. PIPE IS LOCATED AT THE HIGH TIDE LINE. IN THE YARD OF THE TAN HOUSE WITH RED TRIM.

Directions to Station:

PARK AT THE END OF RIDGES COURT. WALK DOWN TO THE SHORE AND HEAD RIGHT (WEST). FOLLOW SHORELINE FOR 200 FEET. PIPE IS LOCATED AT THE BASE OF A SMALL BERM SEPARATING THE MARSH FROM A GRASSY FIELD WITH WILLOW TREES BEHIND IT. BRACKETT ROAD.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:30:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS068 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 4 12.24 **Longitude:** -70 44 40.5

Station Description:

12 INCH ASBESTOS PIPE BUILT INTO STONE RETAINING WALL. PIPE LOCATED AT THE HIGH TIDE LINE.

Directions to Station:

PARK ACROSS FROM 4 PLEASANT POINT DRIVE NEXT TO WOODEN GUARD RAIL (SAME PLACE AS FOR LHPS065). HOP GUARD RAIL, FACE WATER, AND WALK RIGHT FOR 100 FEET. YOU WILL WALK AROUND A SMALL POINT BEFORE REACHING THE PIPE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:15:00			TNTC	0
09/02/2003	11:45:00			>20000	FLOW BUT TOO LOW TO MEASURE

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS081 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 3 21 **Longitude:** -70 44 54

Station Description:

12 INCH METAL PIPE WHICH STICKS OUT OF MIDDLE OF BANK APPROXIMATELY 1 FOOT. ONLY ACCESSIBLE AT LOW TIDE.

Directions to Station:

PARK AT CULVERT AT 220 WALKER BUNGALOW RD (LHPS145). WALK DOWN STREAM TO SHORELINE. WALK RIGHT FOR 200 FEET PASSING BENEATH TWO DOCKS AND AROUND A CORNER TO THE RIGHT. PIPE WILL BE ON YOUR RIGHT BEFORE YOU REACH THE NEXT BEND IN THE SHORELINE TO THE LEFT.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	13:08:00			TNTC	.005
07/11/2003	13:33:00			TNTC	.004
08/01/2003	11:30:00			>20000	.009
09/02/2003	11:05:00				0
09/04/2003	10:25:00			<100	.00005

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS028 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 3 15.06 **Longitude:** -70 44 47.34

Station Description:

12 INCH GREEN PVC PIPE SET INTO ROCKY BANK NEAR HIGH TIDE LINE.

Directions to Station:

ACCESS VIA #3 SAGAMORE CIRCLE. WALK ON WEST SIDE OF LOT DOWN TO WATER. PIPE IS 3 FEET UP THE BANK, HALF WAY BETWEEN TWO DOCKS. NEIGHBOR REPORTS THAT IT IS A NEW DRAIN INSTALLED BY THE CITY. DRAINS CATCHBASIN AND WETLAND NEAR #3 SAGAMORE CIRCLE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	13:47:00			>2000	.02
09/02/2003	12:00:00			4100	FLOW BUT TOO LOW TO MEASURE
09/04/2003	10:05:00			11700	.001

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS003 **Station Name:**

Town: NEW CASTLE **Station Type 1:** PIPE

Latitude: 43 3 29.22 **Longitude:** -70 43 21.72

Station Description:

36 INCH CONCRETE STORM DRAIN. BASE IS FULL OF SAND.

Directions to Station:

FROM RTE 1B, TAKE LITTLE HARBOR RD. PARK ON DRIVEWAY (NOT GRASS) BETWEEN #133 AND #149 ACROSS FROM UTILITY BOX "T7". HEAD SOUTH TOWARD WATER ALONG FLAGSTONE WALKWAY BETWEEN TWO HOUSES. PIPE IS LOCATED AT END OF WALKWAY.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	14:05:00			>2000	0
08/01/2003	10:55:00			2700	.08
09/02/2003	11:00:00			100	FLOW BUT TOO LOW TO MEASURE
09/04/2003	11:00:00			1000	FLOW BUT TOO LOW TO MEASURE
04/13/2004	09:00:00	<100	<100	<100	FLOW BUT NOT POSSIBLE TO MEASURE
04/13/2004	12:55:00	<100	<100	<100	.11
04/14/2004	09:45:00	12	<100	<100	.52
04/14/2004	10:35:00	10	<100	<100	.41
04/14/2004	11:15:00	5	<100	<100	.39
06/29/2004	12:50:00	500	700	600	FLOW BUT TOO LOW TO MEASURE

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS004 **Station Name:**

Town: NEW CASTLE **Station Type 1:** PIPE

Latitude: 43 3 29.2 **Longitude:** -70 43 28.3

Station Description:

LARGE CONCRETE PIPE (36 INCHES) SET IN ROCK WALL AND COVERED BY A ROCK SLAB. DIFFICULT TO SEE. LOCATED AT MID-HIGH TIDE LINE.

Directions to Station:

PARK IN WENTWORTH MARINA LOT. WALK TOWARD MARINA. BEFORE CROSSING SMALL WOODEN BRIDGE, GO TO THE LEFT OF THE BRIDGE ONTO THE ROCK PILE. HEAD LEFT FOR 50 FEET. THE PIPE IS AT THE BASE OF THE ROCK WALL AND IS DIRECTLY IN FRONT OF THE CLOSEST CONDO.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	13:55:00			<10	0
09/02/2003	10:50:00			<100	0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS008 **Station Name:**

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: 43 3 56 **Longitude:** -70 43 16

Station Description:

TIDAL CREEK 3-6 FEET WIDE. DRAINS LARGE TIDAL MARSH IN THE MIDDLE OF NEW CASTLE ISLAND. SAMPLE AT NARROW CHANNEL WITH ROCK EXPOSED AT LOW TIDE WHICH IS JUST DOWNSTREAM OF THE PHRAGMITES STAND IN FRONT OF BEIGE HOUSE. CALL FOR PERMISSION 603-334-6320.

Directions to Station:

TAKE ABIGAIL LANE OFF RTE 1B. DRIVE TO END OF CUL-DE-SAC. WALK AROUND THE RIGHT SIDE OF BEIGE HOUSE. FOLLOW STONE WALK WAYS ACROSS LAWN OF BEIGE HOUSE AND THEN DOWN TO MARSH. GO LEFT AT END OF WALKWAY TO GO AROUND PHRAGMITES.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
08/01/2003	10:30:00			<100	
09/02/2003	11:10:00			100	FLOW BUT NOT POSSIBLE TO MEASURE
09/04/2003	11:15:00			560	.55

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS012 **Station Name:**

Town: NEW CASTLE **Station Type 1:** FACILITY

Latitude: 43 3 45.9 **Longitude:** -70 43 31.56

Station Description:

Directions to Station:

CONSTRUCTION AT WENTWORTH HOTEL HAS INTERFERED WITH ACCESS TO THIS SITE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS015 **Station Name:**

Town: NEW CASTLE **Station Type 1:** PIPE

Latitude: 43 4 9 **Longitude:** -70 43 33

Station Description:

SQUARE CONCRETE PIPE 13 X 15 INCHES. OUTLET FROM ROCK WALL THAT APPEARS TO DRAIN LAWN BETWEEN WHITE CLAPBOARD HOUSE AND BROWN SHINGLE HOUSE. NO FLOW DURING 8/1/03 STORM @ 1005.

Directions to Station:

FROM RTE 1B, TAKE LAUREL LANE TO END. WALK STRAIGHT DOWN TO WATER AND HEAD LEFT FOR 100 YARDS IN THE INTERTIDAL ZONE. COAST WILL TURN TO THE LEFT INTO A SMALL COVE. SOURCE IS LOCATED BETWEEN WHITE CLAPBOARD HOUSE AND BROWN SHINGLE HOUSE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
08/01/2003	10:05:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS019 **Station Name:**

Town: NEW CASTLE **Station Type 1:** PIPE

Latitude: 43 4 17.58 **Longitude:** -70 44 5.82

Station Description:

12 INCH CONCRETE PIPE AT BASE OF STONE WALL. DRAINS CATCH BASIN ACROSS THE STREET. THE CATCH BASIN ONLY RECEIVES FLOW FROM A SMALL GRASSY AREA AND A SMALL PORTION OF ROAD. NO FLOW DURING STORM ON 8/1/03 @ 0955.

Directions to Station:

SAME LOCATION AS LHPS020 EXCEPT THIS SOURCE IS 100 FEET CLOSER TO NEW CASTLE THAN LHPS020. SOURCE IS LOCATED BENEATH A BIRCH TREE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
08/01/2003	09:45:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS020 **Station Name:**

Town: NEW CASTLE **Station Type 1:** PIPE

Latitude: 43 4 17.22 **Longitude:** -70 44 7.56

Station Description:

12 INCH CONCRETE PIPE. MORE THAN HALF FULL OF SEDIMENT. DRAINS A SINGLE CATCH BASIN ACROSS THE ROAD. THE CATCHMENT AREA FOR THE CATCH BASIN IS GRASSY AND SMALL SO THERE DOES NOT APPEAR TO BE MUCH FLOW FROM THIS SOURCE. DRY DURING STORM ON 8/1/03 @ 0955.

Directions to Station:

PARK AT GOAT ISLAND SALT WATER FISHING ACCESS SIGN ON RTE 1B. WALK TOWARD NEW CASTLE ISLAND. THE SOURCE IS 30 FEET FROM THE PARKING AREA BELOW THE FIRST POST IN THE GUARD RAIL THAT STARTS JUST PAST THE PARKING AREA AND RUNS TOWARD NEW CASTLE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
08/01/2003	09:45:00				0

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS141 **Station Name:** WENTWORTH MARINA-CENTER DOCK

Town: NEW CASTLE **Station Type 1:** FACILITY

Latitude: 43 3 30.78 **Longitude:** -70 43 36.66

Station Description:

WENTWORTH BY THE SEA MARINA, MIDDLE OF CENTER DOCK, DOCK 'C', END OF SLIP #17.

Directions to Station:

MIDDLE OF CENTER DOCK.

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
06/09/2003	11:55:00	NO DATA		=90	
06/16/2003	11:25:00	NO DATA		=20	
06/23/2003	09:05:00	NO DATA		<10	
07/07/2003	09:25:00	NO DATA		=20	
08/11/2003	09:37:00	NO DATA		=50	
08/18/2003	08:29:00	NO DATA		=10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: 1-SMP **Station Name:** SOUTH MILL POND OUTFLOW AT MARCY ST

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: 43 4 21.09 **Longitude:** -70 45 2.2

Station Description:

OUTFLOW OF SOUTH MILL POND AT MARCY STREET IN PORTSMOUTH.

Directions to Station:

PARK IN FRONT OF "THE OLD FISH MARKET" STORE. CROSS ROAD TO THE SIDE CLOSEST TO SOUTH MILL POND. GO OVER GUARD RAIL TO THE LEFT OF THE OUTLET (FACING UPSTREAM). USE LONG SAMPLING POLE TO COLLECT SAMPLE FROM MIDDLE OF FLOW RUNNING THROUGH TIDE GATE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:00:00			190	
09/02/2003	11:30:00			30	EBBING TIDAL FLOW
09/04/2003	11:15:00			150	
09/19/2003	10:11:00			60	EBBING TIDAL FLOW

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T16 **Station Name:** BACK CHANNEL AT W-C MANSION

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

BACK CHANNEL NEAR GREEN CAN OFF WENTWORTH-COOLIDGE MANSION. USE CHEST WADERS AND LONG SAMPLING POLE TO COLLECT SAMPLE AS CLOSE TO GREEN CAN AS POSSIBLE.

Directions to Station:

FOLLOW SIGNS TO WENTWORTH COOLIDGE MANSION. PARK IN PARKING LOT. WALK DOWN LAWN OF MANSION TO SMALL PEBBLE BEACH. USE CHEST WADERS TO WALK OUT AS CLOSE AS POSSIBLE TO THE CAN.

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: 04-SAG **Station Name:** SAGAMORE CREEK FROM RTE 1 BRIDGE

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: 43 3 3 **Longitude:** -70 46 15

Station Description:

SAGAMORE CREEK FROM ROUTE 1 BRIDGE. COLLECT SAMPLE FROM MIDDLE OF THE UPSTREAM (WESTERN) SIDE OF THE BRIDGE. LOWER SAMPLE BOTTLE TO THE WATER USING BRIDGE SAMPLING APPARATUS.

Directions to Station:

DRIVE WEST ON PEVERLY HILL RD. GO LEFT AT INTERSECTION WITH RTE 1. IMMEDIATELY TURN LEFT AND PARK IN LOT FOR "BRATSKELLAR". WALK IN BREAKDOWN LANE TO MIDDLE OF BRIDGE. DO NOT PARK ON BRIDGE. DO NOT ATTEMPT TO CROSS THE ROAD.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	11:58:00			TNTC	
09/02/2003	11:45:00			60	EBBING TIDAL FLOW
09/04/2003	10:15:00			>2000	EBBING TIDAL FLOW
06/29/2004	11:45:00	400	570	3620	EBBING TIDAL FLOW

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS145 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 3 22 **Longitude:** -70 44 48

Station Description:

10 INCH CULVERT UNDER WALKER BUNGALOW ROAD. SAMPLE AT DOWNSTREAM CULVERT OUTLET.

Directions to Station:

TAKE LITTLE HARBOR ROAD UNTIL YOUR FIRST LEFT WHICH IS WALKER BUNGALOW ROAD. ACCESS BY #220 WALKER BUNGALOW ROAD, 2 STORY RED HOUSE WITH EXPOSED BASEMENT, LARGE SHED, AND RED BARN. CULVERT IS RIGH AFTER THE SHED.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:47:00			>2000	<.002
08/01/2003	11:15:00			TNTC	.02
09/02/2003	10:50:00			3200	FLOW BUT TOO LOW TO MEASURE
09/04/2003	10:15:00			1100	.008

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS146 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** PIPE

Latitude: 43 3 21 **Longitude:** -70 44 55

Station Description:

15" CMP 50 FEET FROM LHPS081. THIS SOURCE TO THE RIGHT OF THE GREY HOUSE AND THE LEFT OF LHPS081. SAMPLE AT CULVERT OUTLET WHICH IS IN A THICKET OF ROSE BUSHES ABOVE A ROCK PILE. THE PIPE IS NOT VISIBLE. NOT POSSIBLE TO MEASURE FLOW BECAUSE OF ROSE BUSHES.

Directions to Station:

PARK AT LOCATION FOR LHPS145. WALK DOWN STREAM AT LHPS145 TO WATER. WALK ALONG SHORE TOWARD THE RTE 1A BRIDGE. PASS UNDER 2 PIERS AND THEN TURN A CORNER TO THE RIGHT. GO ANOTHER 100 YARDS. THE SOURCE IS IN A THICKET IN THE CORNER. YOU WILL PASS LHPS081.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
08/01/2003	11:25:00			>20000	
09/02/2003	11:05:00			10400	FLOW BUT TOO LOW TO MEASURE
09/04/2003	10:35:00			>20000	FLOW BUT NOT POSSIBLE TO MEASURE

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB1 **Station Name:**

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

OFF FROST POINT JETTY AT GREEN CAN AT MOUTH OF LITTLE HARBOR

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:38:00			<10	
09/04/2003	10:15:00			10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB13 **Station Name:**

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: 43 3 29.88 **Longitude:** -70 43 44.04

Station Description:

BACK CHANNEL AT ROUTE 1B BRIDGE BY WENTWORTH MARINA (DOWNSTREAM/LH SIDE)

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:27:00			60	
09/04/2003	10:04:00			20	
09/18/2003	11:10:00			<10	
09/19/2003	09:43:00			10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB16 **Station Name:**

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

MIDDLE OF BACK CHANNEL

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:10:00			20	
09/04/2003	09:46:00			40	
09/18/2003	10:52:00			<10	
09/19/2003	09:27:00			<10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB18 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

SAGAMORE CREEK AT ROUTE 1A BRIDGE (UPSTREAM SIDE)

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:19:00			10	
09/04/2003	09:57:00			10	
09/18/2003	11:03:00			<10	
09/19/2003	09:35:00			<10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB19 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

SAGAMORE CREEK NARROWS
DOWNSTREAM OF WITCH COVE MARINA

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:14:00			80	
09/04/2003	09:50:00			10	
09/18/2003	10:55:00			<10	
09/18/2003	10:56:00			<5	
09/19/2003	09:30:00			<10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB2 **Station Name:**

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

ALONG NEW CASTLE SHORELINE

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:35:00			30	
09/04/2003	10:12:00			<10	
09/19/2003	09:50:00			10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB5 **Station Name:**

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

BETWEEN SHAPLEIGH AND GOAT ISLANDS, NORTH EDGE OF BACK CHANNEL

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:07:00			<10	
09/04/2003	09:43:00			20	
09/18/2003	10:48:00			10	
09/19/2003	09:24:00			<10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB6 **Station Name:**

Town: RYE **Station Type 1:** ESTUARY

Latitude: 43 3 11.88 **Longitude:** -70 43 41.88

Station Description:

WITCH CREEK AT SHEAFES POINT

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:32:00			10	
09/04/2003	10:07:00			<10	
09/18/2003	11:17:00			<10	
09/19/2003	09:46:00			10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB8 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

WITCH COVE MARINA IN SAGAMORE CREEK

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:16:00			50	
09/04/2003	09:53:00			<10	
09/18/2003	10:58:00			10	
09/19/2003	09:33:00			<10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHB9 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

BETWEEN SHAPLEIGH AND MAINLAND,
NORTH EDGE OF BACK CHANNEL

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:04:00			30	
09/04/2003	09:39:00			120	
09/18/2003	10:44:00			10	
09/19/2003	09:21:00			20	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T6 **Station Name:**

Town: RYE **Station Type 1:** ESTUARY

Latitude: 43 3 9 **Longitude:** -70 43 47

Station Description:

WITCH CREEK AT SHEAFES POINT. SAMPLE COLLECTED FROM A BOAT AS CLOSE TO SHORE AS POSSIBLE.

Directions to Station:

SAMPLED BY BOAT

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:31:00			40	
09/04/2003	10:07:00			10	
09/18/2003	11:19:00			<10	
09/19/2003	09:46:00			10	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T13A **Station Name:** BACK CHANNEL FROM RTE 1B BRIDGE

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: 43 3 29 **Longitude:** -70 43 47

Station Description:

BACK CHANNEL FROM ROUTE 1B BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE BRIDGE ON THE SIDE CLOSEST TO BACK CHANNEL. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.

Directions to Station:

PARK ON ROUTE 1B AT THE WEST SIDE OF THE BRIDGE. CROSS THE ROAD AND WALK ACROSS THE BRIDGE ON THE BACK CHANNEL SIDE WHERE THERE IS A SIDEWALK.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	14:22:00			60	
07/11/2003	14:25:00			50	
09/19/2003	09:45:00			<10	
04/13/2004	08:45:00	<10	<10	<10	
04/13/2004	12:45:00	30	<10	<10	
04/14/2004	09:35:00	12	<10	<10	EBBING TIDAL FLOW
04/14/2004	10:20:00	10	10	20	EBBING TIDAL FLOW
04/14/2004	11:05:00	15	<10	<10	EBBING TIDAL FLOW
06/29/2004	12:40:00	10	20	10	EBBING TIDAL FLOW

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T14 **Station Name:** BERRYS BROOK FROM RTE 1A BRIDGE

Town: RYE **Station Type 1:** ESTUARY

Latitude: 43 2 52 **Longitude:** -70 43 40

Station Description:

BERRY'S BROOK AT ROUTE 1A WOODEN BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE BRIDGE FROM THE SIDE FACING AWAY FROM THE OCEAN. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.

Directions to Station:

FROM PORTSMOUTH, TAKE ROUTE 1A TOWARDS ODIORNE STATE PARK. PARK IN THE DIRT PULL-OFF ON THE BEFORE THE WOODEN BRIDGE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:25:00			400	
09/02/2003	11:20:00			40	FLOODING TIDAL FLOW
09/04/2003	10:35:00			10	EBBING TIDAL FLOW
09/19/2003	09:55:00			40	
04/13/2004	08:30:00	<10	<10	10	
04/13/2004	12:30:00	<10	160	<10	
04/14/2004	09:20:00	24	20	40	EBBING TIDAL FLOW
04/14/2004	10:10:00	17	10	10	EBBING TIDAL FLOW
04/14/2004	10:55:00	16	10	<10	EBBING TIDAL FLOW
06/29/2004	12:30:00	32	50	50	EBBING TIDAL FLOW

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T18 **Station Name:** SAGAMORE CREEK AT RTE 1A BRIDGE

Town: PORTSMOUTH **Station Type 1:** ESTUARY

Latitude: 43 3 16 **Longitude:** -70 44 55

Station Description:

SAGAMORE CREEK AT ROUTE 1A BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE BRIDGE ON THE SIDE FACING AWAY FROM THE OCEAN. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.

Directions to Station:

TAKE ROUTE 1A SOUTH FROM PORTSMOUTH. PARK IN PARKING LOT FOR SAGAMORE GENERAL STORE ON THE SOUTH SIDE OF THE BRIDGE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:37:00			40	
09/19/2003	09:35:00			10	
06/29/2004	12:00:00	10	<10	50	EBBING TIDAL FLOW

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T19 **Station Name:** WITCH COVE MARINA

Town: RYE **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

END OF DOCK AT WITCH COVE MARINA

Directions to Station:

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: T7 **Station Name:** BERRYS BROOK AT BRACKETT ROAD BRIDGE

Town: RYE **Station Type 1:** ESTUARY

Latitude: 43 2 37 **Longitude:** -70 44 4

Station Description:

UPSTREAM OF BRIDGE OVER BERRYS BROOK ON BRACKETT ROAD (WEST SIDE OF BRIDGE). WHEN FACING UPSTREAM, TAKE SAMPLE FROM THE RIGHT SIDE OF THE BROOK USING A SAMPLING POLE. GET AS CLOSE AS POSSIBLE TO THE MIDDLE OF THE STREAM BY STANDING ON ROCKS.

Directions to Station:

TAKE ROUTE 1A FROM PORTSMOUTH TOWARD ODIORNE STATE PARK IN RYE. BEFORE REACHING THE ROUTE 1A WOODEN BRIDGE, TURN RIGHT ONTO BRACKETT ROAD. FOLLOW BRACKETT ROAD UNTIL IT CROSSES BERRYS BROOK (1/4 MILE). PARK IN PULL-OUT ON RIGHT SIDE BEFORE THE BRIDGE.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:20:00			730	
09/02/2003	11:25:00			30	EBBING TIDAL FLOW
09/04/2003	10:30:00			60	EBBING TIDAL FLOW
06/29/2004	12:20:00	130	180	170	EBBING TIDAL FLOW

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS147 **Station Name:** WENTWORTH MARINA-WESTERN MOST DOCK

Town: NEW CASTLE **Station Type 1:** FACILITY

Latitude: 43 3 29 **Longitude:** -70 43 40

Station Description:

MIDDLE OF WESTERN MOST DOCK, DOCK 'E', SLIP/POST #9/8.

Directions to Station:

WESTERN MOST DOCK.

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
06/09/2003	11:50:00	NO DATA		=110	
06/16/2003	11:20:00	NO DATA		=20	
06/23/2003	09:02:00	NO DATA		<10	
07/07/2003	09:20:00	NO DATA		<10	
08/11/2003	09:30:00	NO DATA		<10	
08/18/2003	08:23:00	NO DATA		=30	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS148 **Station Name:** WENTWORTH MARINA-EASTERN MOST DOCK

Town: NEW CASTLE **Station Type 1:** FACILITY

Latitude: 43 3 27 **Longitude:** -70 43 32

Station Description:

MIDDLE OF EASTERN MOST DOCK, SAMPLE OFF DOCK 'A', END OF SLIP #14.

Directions to Station:

EASTERN MOST DOCK.

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
06/09/2003	12:00:00	NO DATA		=50	
06/16/2003	11:30:00	NO DATA		<10	
06/23/2003	09:10:00	NO DATA		=10	
07/07/2003	09:30:00	NO DATA		<5	
08/11/2003	09:45:00	NO DATA		=70	
08/18/2003	08:35:00	NO DATA		=20	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS053 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** SEEP

Latitude: 43 3 56.6 **Longitude:** -70 45 12.8

Station Description:

SEEP AND/OR LAND RUNOFF FROM THE LITTLE HARBOR SCHOOL AREA. SAMPLE COLLECTED FROM CASCADE DOWN LIP OF THE SALT MARSH.

Directions to Station:

FROM LHPS055, HEAD 50 FEET NORTH TOWARD LITTLE HARBOR SCHOOL. STATION IS LOCATED AT THE HEAD OF A NARROW GULLY IN THE SALT MARSH.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	13:05:00			>2000	

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS054 **Station Name:**

Town: PORTSMOUTH **Station Type 1:** SEEP

Latitude: 43 3 56.4 **Longitude:** -70 45 13

Station Description:

SEEP AND/OR LAND RUNOFF FROM THE DIRECTION OF THE HOUSE BETWEEN LITTLE HARBOR SCHOOL AND THE CEMETARY. SAMPLE TAKEN AT THE POINT WHERE THE RUNOFF CASCADES DOWN THE LIP OF THE SALT MARSH.

Directions to Station:

FROM LHPS055, HEAD 30 FEET TOWARD LITTLE HARBOR SCHOOL. STATION IS AT THE HEAD OF A SMALL GULLY THAT IS FULL OF BROKEN GLASS AND IS STAINED RED WITH IRON OXIDES.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
07/11/2003	12:55:00			TNTC	.15

LITTLE HARBOR TMDL SAMPLING STATIONS

Station ID: LHPS003SH **Station Name:** SHORELINE ADJACENT TO LHPS003

Town: NEW CASTLE **Station Type 1:** ESTUARY

Latitude: **Longitude:**

Station Description:

STATION IS 5-10 FEET OFFSHORE FROM THE LOCATION WHERE DISCHARGE FROM LHPS003 STORMWATER PIPE ENTERS LITTLE HARBOR. SAMPLE IS COLLECTED USING A LONG SAMPLING POLE.

Directions to Station:

SAME AS FOR LHPS003

Picture not available.

LITTLE HARBOR TMDL SAMPLING RESULTS

Date	Time	EC (#/100ml)	ENT (#/100ml)	TFC (#/100ml)	FLOW (cfs)
04/13/2004	09:00:00	<50	<50	<50	
04/13/2004	13:00:00	<100	<100	<100	
04/14/2004	09:50:00	<100	<100	<100	
04/14/2004	10:40:00	<50	<50	100	
04/14/2004	11:20:00	<100	<100	<100	
06/29/2004	12:55:00	2	20	2	

APPENDIX B

Watershed Treatment Model Summary

INTRODUCTION

Annual fecal coliform loads to the assessment units are estimated using the Watershed Treatment Model (version 3.1) from the Center for Watershed Protection. The WTM incorporates the area of land in different land use classes and information on secondary sources such as illicit connections to estimate the total annual load from a watershed. The model was developed by the Center for Watershed Protection with funding from the U.S. Environmental Protection Agency, Region V, Office of Wetlands, Oceans, and Watersheds.

In general, fecal coliform loads are estimated for primary land uses and secondary sources. The model can also account for treatment methods to mitigate the loads. However, the model does not account for bacteria die-off in the environment. Details of the model are provided in the manual (CWP, 2002), which can be purchased online at www.cwp.org. **This appendix only provides a brief overview of the model components and any non-default assumptions used in the Little Harbor TMDL.**

MODEL DESCRIPTION

Loads from Primary Land Uses

The primary land uses in the model are shown in Table B1.

Table B1: Primary land use coefficients in the Watershed Treatment Model

Land Use		Impervious Cover (%)	FC in Runoff (MPN/100ml)	Annual FC Loading Rates (bill org/acre)
Residential	LDR (<1du/acre)	11	7800	NA
	MDR (1-4 du/acre)	21	7800	NA
	HDR (>4 du/acre)	33	7800	NA
	Multifamily	44	7800	NA
Commercial		72	7800	NA
Roadway		80	20000	NA
Industrial		53	20000	NA
Forest		NA	NA	12
Rural		NA	NA	39
Open Water		NA	NA	0

Shaded cells are customized inputs for LHTMDL. All other values are default in the WTM.

Loading from residential, commercial, roadway, and industrial land uses are calculated using the Simple Method by multiplying the annual runoff by the fecal coliform concentration in the runoff.

$$L = CF \times R \times C \times A$$

Where:
L = Annual load (billion org/year)
R = Annual runoff (in.)
C = Fecal coliform concentration (MPN/100ml) (input value was customized for Little Harbor TMDL, see next section).
A = Area (acres) (see Table B8)
CF = Conversion factor = 1.03E-03

Annual runoff is calculated by:

$$R = P \times P_j \times (0.05 + 0.9 \times I_a)$$

Where:
R = Annual runoff (in.)
P = Annual rainfall (in.)
P_j = Fraction of annual rainfall events that produce runoff (assumed to be 0.9)
I_a = Impervious fraction (see Table B1)

Loading from undeveloped forest and rural lands is estimated as the product of the area of the land use type and an assumed loading rate from the literature (shown in Table B1).

Loads from Secondary Sources

Three secondary sources were considered for the TMDL: illicit connections, failing septic systems, and boat discharges.

The load from illicit connections is estimated using the following equation:

$$Illicit = d \times f_{i,res} \times p \times q \times FC \times CF + b \times f_{i,biz} \times q_{biz} \times FC \times CF$$

Where:
Illicit = annual load of fecal coliforms from illicit connections (billion organisms per year)
d = number of dwellings in the watershed (see Table B8)
$f_{i,res}$ = fraction of dwellings with illicit connections = 0.001
p = average number of people per dwelling = 2.7
q = water consumption per person per day = 70 gal/person/day
FC = fecal coliform concentration in raw sewage (cts/100ml) (input value was customized for Little Harbor TMDL, see next section)
b = number of businesses in the watershed=1 per acre of commercial/industrial property
$f_{i,biz}$ = fraction of businesses with illicit connections=0.01
q_{biz} = water consumption per business per day = 100 gal/day
CF = conversion factor = 1.3797E-05 (37.8 100ml/gal * 365 d/yr * 1E-9 bill org/org)

Note this equation is somewhat simplified compared to the equation in the WTM spreadsheet because wash-water only discharges are not considered. See discussion of illicit connection discharges in the next section for an explanation.

The load from failing septic systems is estimated using following equation:

$$Septic = d \times f_{unsewered} \times f_{failure} \times p \times q \times FC_{septic}$$

Where:
Septic = annual load of fecal coliforms from failing septic systems (billion organisms per year)
d = number of dwellings in the watershed (see Table B8)
$f_{unsewered}$ = fraction of dwellings with septic systems (see Table B8)
$f_{failure}$ = fraction of systems in failure = 0.3
p = average number of people per dwelling = 2.7
q = water consumption per person per day = 70 gal/person/day
FC_{septic} = fecal coliform concentration in septic system discharge (cts/100ml) (input value was customized for Little Harbor TMDL, see next section)
CF = conversion factor = 1.3797E-05 (37.8 100ml/gal * 365 d/yr * 1E-9 bill org/org)

The load from boat discharges is calculated using the following equation:

$$Boat = v \times f_{occupied} \times p_{boat} \times q_{boat} \times FC \times t$$

Where:
Boat = annual load of fecal coliforms from boat discharges (billion organisms per year)
v = number of boats in harbor (see Table B7)
$f_{occupied}$ = fraction of boats occupied (input value was customized for Little Harbor TMDL, see next section)
p_{boat} = average number of people per boat = 2
q_{boat} = water consumption per person per day on a boat = 8 gal/person/day
FC = fecal coliform concentration in raw sewage = 10,000,000 cts/100ml
t = boating season duration (d) (see Table B7)
CF = conversion factor = 37.8 100ml/gal * 1E-9 bill org/org

Load Mitigation

The WTM can account for the effect of load reduction programs such as street sweeping, boat pump outs, and pet waste ordinances. The only mitigation program that was included in the TMDL calculations was the boat sewage pump outs. The total gallons of sewage pumped from boats in Little Harbor in 2003 was subtracted from the modeled volume of sewage that was generated and discharged.

CUSTOMIZED MODEL ASSUMPTIONS FOR LITTLE HARBOR TMDL

DES used default assumptions in the WTM except for the following parameters that were customized to the Little Harbor area. The Center for Watershed Protection encourages users of the model to substitute site-specific information in place of default assumptions in the model. All customized inputs to the model are summarized in Table B7.

Urban Stormwater Runoff

The default fecal coliform concentration in stormwater runoff in the model is 20,000 cts/100ml. However, the DES stormwater sampling in 2003-2004 (Appendix A) showed that the average fecal coliform concentration is 7,800 cts/100ml (Table B2). Therefore, 7,800 cts/100ml was used in the model to customize the model for the local conditions. All of the other default values in the model were used.

Table B2: Average fecal coliform concentrations and loads from storm drain sources in 2003 and 2004

Summary of Stormwater FC Concentrations

Average of TOTAL FECAL COLIFORM	
Stationid	Total
1-SMP	108
LHPS003	690
LHPS004	55
LHPS008	253
LHPS015	NA
LHPS019	NA
LHPS020	NA
LHPS028	5,933
LHPS042	4,380
LHPS050	NA
LHPS053	2,000
LHPS054	20,000
LHPS055	6,392
LHPS065	NA
LHPS066	NA
LHPS068	20,000
LHPS081	13,367
LHPS126	806
LHPS137	20,000
LHPS145	6,575
LHPS146	16,800
MEAN	7,824
MEDIAN	5,933
MAXIMUM	20,000

**FC concentrations in cts/100ml*

Summary of Stormwater FC Loads

Average of FC LOAD		
Stationid	Total	%of Total
1-SMP	NA	NA
LHPS003	0.99	0.4%
LHPS004	0.00	0.0%
LHPS008	7.67	3.3%
LHPS015	0.00	0.0%
LHPS019	0.00	0.0%
LHPS020	0.00	0.0%
LHPS028	0.49	0.2%
LHPS042	53.71	23.3%
LHPS050	0.00	0.0%
LHPS053	NA	NA
LHPS054	73.41	31.8%
LHPS055	73.48	31.8%
LHPS065	0.00	0.0%
LHPS066	0.00	0.0%
LHPS068	0.49	0.2%
LHPS081	1.71	0.7%
LHPS126	15.72	6.8%
LHPS137	0.00	0.0%
LHPS145	2.58	1.1%
LHPS146	0.51	0.2%
MEAN	12.15	
MEDIAN	0.49	
MAXIMUM	73.48	
TOTAL	230.76	

**FC loads in billion org/day*

Illicit Connections and Failing Septic Systems

No wastewater treatment facilities discharge to the Little Harbor assessment units. Therefore, the dry weather loads of bacteria should be limited to illicit connections and failing septic systems.

DES calibrated the portion of the Watershed Treatment Model for illicit connections and failing septic systems using dry weather *E. coli* data from two stations in the watershed (05-BER and 05-SAG). The average load at 05-BER and 05-SAG during dry weather days was expected to be equal to modeled load from failing septic systems and illicit connections.

Monthly dry-weather samples for *E. coli* at these stations from the DES Ambient Rivers Monitoring Program were matched with flow values to estimate the daily load of *E. coli* during dry weather between 2001 and 2004 (Table B3). Figure B1 shows that the loads are relatively constant for rainfall values less than 0.5 inches. Extrapolated over the course of a year, the total load from dry-weather inputs at 05-BER and 05-SAG would be 2,573 and 109 billion organisms per year. The WTM with default assumptions predicts much higher loads at these stations (see Table B4). The likely cause of the over prediction is that bacteria die off rates are not considered in the WTM.

Table B3: *E. coli* loads at 05-BER in Berrys Brook and 05-SAG on Sagamore Creek, 2001-2004

Stationid	Date	Rainfall (in)	Flow (cfs)	E.coli (cts/100ml)	EC Load (bill org/d)
05-BER	3/20/2001	0	21.16	10	5.18
05-BER	3/19/2003	0	19.78	10	4.84
05-BER	3/23/2004	0	9.2	10	2.25
05-BER	5/15/2001	0	2.024	20	0.99
05-BER	11/18/2003	0	4.4	30	3.23
05-BER	12/10/2003	0	3.1	30	2.28
05-BER	7/23/2001	0	0.46	50	0.56
05-BER	3/19/2002	0	4.14	50	5.06
05-BER	11/13/2001	0	0.2944	80	0.58
05-BER	5/20/2003	0	5.06	80	9.90
05-BER	6/28/2001	0	1.886	100	4.61
05-BER	7/24/2003	0	0.61	110	1.64
05-BER	10/22/2002	0	0.598	180	2.63
05-BER	6/15/2004	0	2	180	8.81
05-BER	8/13/2002	0	0.1426	420	1.47
05-BER	4/20/2004	0.03	11	10	2.69
05-BER	12/5/2001	0.04	0.46	20	0.23
05-BER	4/19/2001	0.07	17.48	10	4.28
05-BER	6/29/2004	0.21	1.5	210	7.71
05-BER	7/16/2002	0.33	0.552	170	2.30
05-BER	8/14/2001	0.36	0.3174	160	1.24
05-BER	6/20/2003	0.43	4.4	180	19.38
05-BER	11/26/2002	0.48	5.98	110	16.10
05-BER	4/16/2002	0.56	9.2	30	6.75
05-BER	5/18/2004	0.59	4.9	100	11.99
05-BER	4/23/2003	0.65	12.42	60	18.23
05-BER	9/16/2003	0.86	3.726	750	68.38
05-BER	10/28/2003	0.97	15.18	270	100.29
05-BER	6/24/2002	1.27	10.58	300	77.66
05-BER	9/24/2002	1.27	0.368	420	3.78
05-BER	10/17/2001	1.47	1.38	10500	354.55
05-BER	5/14/2002	2.36	55.2	490	661.82
05-BER	12/16/2002	2.47	19.78	560	271.03
05-BER	3/23/2001	4.29	158.7	110	427.15
Dry-Weather Average				**97**	**4.7**
Overall Average				**465**	**62.0**

Stationid	Date	Rainfall (in)	Flow (cfs)	E.coli (cts/100ml)	EC Load (bill org/d)
05-SAG	3/20/2001	0	1.84	10	0.45
05-SAG	3/19/2003	0	1.72	10	0.42
05-SAG	5/15/2001	0	0.176	10	0.04
05-SAG	7/23/2001	0	0.04	10	0.01
05-SAG	11/13/2001	0	0.0256	10	0.01
05-SAG	3/19/2002	0	0.36	10	0.09
05-SAG	10/22/2002	0	0.052	10	0.01
05-SAG	11/18/2003	0	0.48	10	0.12
05-SAG	3/23/2004	0	0.64	10	0.16
05-SAG	6/15/2004	0	0.176	10	0.04
05-SAG	5/20/2003	0	0.44	30	0.32
05-SAG	12/10/2003	0	0.344	50	0.42
05-SAG	6/28/2001	0	0.164	79	0.32
05-SAG	8/13/2002	0	0.0124	90	0.03
05-SAG	7/24/2003	0	0.116	150	0.43
05-SAG	9/11/2001	0.01	0.0276	10	0.01
05-SAG	4/20/2004	0.03	1.04	10	0.25
05-SAG	12/5/2001	0.04	0.04	10	0.01
05-SAG	4/19/2001	0.07	1.52	10	0.37
05-SAG	6/29/2004	0.21	0.37	40	0.36
05-SAG	7/16/2002	0.33	0.048	30	0.04
05-SAG	8/14/2001	0.36	0.0276	10	0.01
05-SAG	6/20/2003	0.43	0.348	80	0.68
05-SAG	11/26/2002	0.48	0.52	10	0.13
05-SAG	4/16/2002	0.56	0.8	240	4.70
05-SAG	5/18/2004	0.59	0.388	110	1.04
05-SAG	4/23/2003	0.65	1.08	270	7.14
05-SAG	9/16/2003	0.86	0.324	430	3.41
05-SAG	10/28/2003	0.97	1.32	350	11.30
05-SAG	6/24/2002	1.27	0.92	60	1.35
05-SAG	9/24/2002	1.27	0.032	240	0.19
05-SAG	10/17/2001	1.47	0.12	1400	4.11
05-SAG	5/14/2002	2.36	4.8	430	50.50
05-SAG	12/16/2002	2.47	1.72	170	7.15
05-SAG	3/23/2001	4.29	13.8	5	1.69
Dry-Weather Average				**29.5**	**0.2**
Overall Average				**126.1**	**2.8**

Note for Table B3: Flow for 05-BER was taken from the Berrys Brook streamgage if when data were available and listed as being reliable by USGS (May 2003 to early August 2003, late October 2003 to early December 2003, late March 2004 to mid June 2004). For all other dates, flow was estimated using an area transposition from the flow in the Oyster River. The ratio of the watershed areas is 0.46 (5.56 sq miles vs 12.10 sq miles). A regression between the daily flows at the two gages showed a relationship of BB = 0.42*OR + 2.44, which validates the area transposition approach. Flow for 05-SAG

was also calculated using an area transposition with the Oyster River gage. The ratio between the Oyster River watershed and the 05-SAG watershed is 0.04 (0.49 sq miles vs. 12.10 sq. miles). However, the last measurement at 05-SAG on 6/15/04 did not have a corresponding flow in the Oyster River. For this day, the flow was estimated from an area transposition from the Berrys Brook gage.

Figure B1: Relationship between *E. coli* load and rainfall at 05-BER and 05-SAG

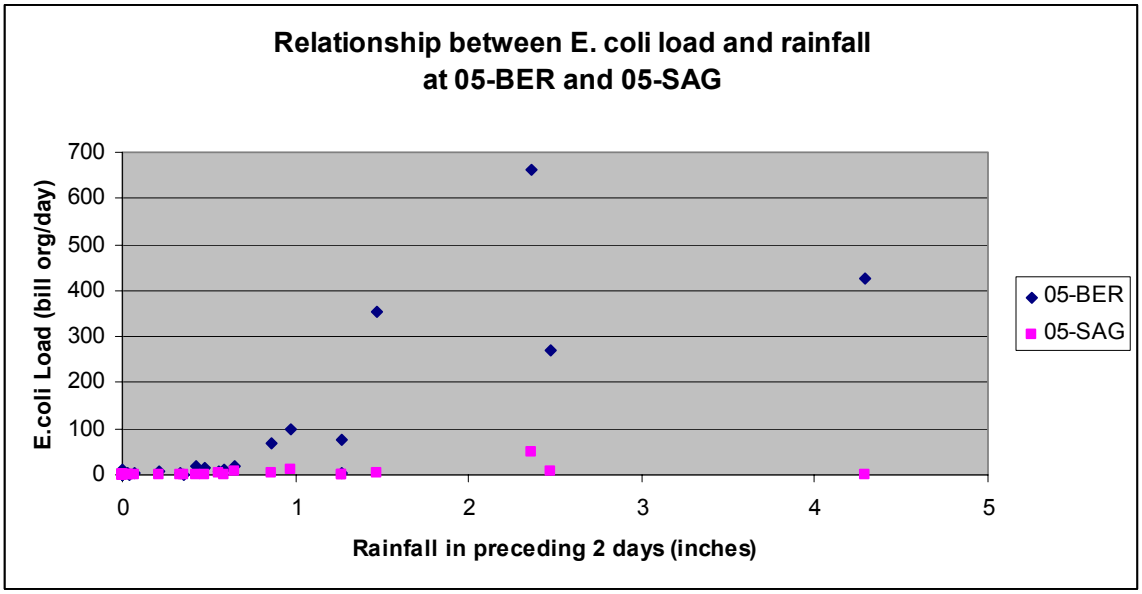


Table B4: Comparison of measured and modeled dry-weather loads at 05-BER and 05-SAG

Watershed	Average Dry-weather EC Load (bill org/d)*	FC:EC ratio**	Measured Annual FC load (bill org/yr)	Modeled Annual FC Load (bill org/yr)	Ratio
05-BER	4.7	1.5	2,573	3,558,239	0.00072
05-SAG	0.2	1.5	109	16,776	0.0065
Average					0.0036

** Dry weather was defined as >0.5 inches of rain in the previous two days.*
*** Average ratio of fecal coliforms to E. coli measured at freshwater sites for the LHTMDL.*

DES calibrated the WTM by multiplying the default value for fecal coliform concentration in raw sewage (10,000,000 cts/100ml) by the average ratio in Table (0.0036). The loads from failing septic systems and illicit connections are linearly related to the assumed concentration for fecal coliforms in raw sewage. Therefore, by making this substitution, the model was calibrated to the local conditions in the Little Harbor watershed.

In addition, the WTM was customized in the following ways:

- It was assumed that the fecal coliform concentration for illicit connections from businesses were the same as for illicit connections from homes. The default WTM reduces the fecal coliform concentration for business illicit connections

to account for dilution with wash water. The Little Harbor watershed does not have many manufacturing facilities. Therefore, it was not reasonable to assume wash water dilution.

- The WTM does not have a default assumption for bacteria die-off during subsurface transport. For other parameters such as nitrogen, the WTM assumes that 10% of the failing septic systems discharge directly to a waterbody (without attenuation). The other 90% of the failing systems discharge to subsurface flow, during which 50% of the nitrogen is attenuated. For the Little Harbor TMDL, the same framework was used for fecal coliforms with the assumption the 75% of the fecal coliforms in subsurface flow are attenuated. The basis for this assumption is that fecal coliforms will be removed from subsurface flow at a faster rate than nitrogen.
- The fraction of dwellings without sewer service was estimated in several ways. For the Berrys Brook, Sagamore Creek and Witch Creek watersheds, DES calculated the total area of parcels in each watershed that are near City of Portsmouth sewer lines (and therefore are charged fees for sewer service). No parcels in Rye have sewer service. Therefore, the area covered by parcels with sewer fees divided by the total area of the watershed should approximate the fraction of dwellings with sewer service. These calculations were further stratified by urbanized areas as necessary. For the New Castle watershed, DES Shellfish Program records provided information on the approximate percentage of shoreline properties with sewer service along the southern edge of New Castle. The New Castle watershed does not extend very far from the shore; therefore, the shoreline property records were considered adequate.
- If illicit connections and failing septic systems discharge to storm sewers, it is possible that these loads would be counted twice: once for their discharge to the system and a second time as part of the stormwater load. However, DES used a lower fecal coliform concentration in stormwater (7,800 cts/100ml) than the default assumption for the model (20,000 cts/100ml). The lower concentration is not indicative of illict discharges. Therefore, it is unlikely that discharges from illicit connections and failing septic systems are being double counted.

Marinas/Boat Discharges

In June, July, and August 2003, the DES Shellfish Program measured fecal coliforms at the dock of the marina to observe the effect, if any, that overboard discharges had on water quality in the marina. The resulting data show that the fecal coliform concentrations fluctuate but average around 30 cts/100ml during the summer season (Table B5).

Table B5: Fecal coliform concentrations at the Wentworth-by-the Sea marina in 2003

StationID	Station	Date	Time	FC (cts/100ml)
LHPS141	WENTWORTH MARINA-CENTER DOCK	06/09/2003	11:55:00	90
LHPS147	WENTWORTH MARINA-WESTERN MOST DOCK	06/09/2003	11:50:00	110
LHPS148	WENTWORTH MARINA-EASTERN MOST DOCK	06/09/2003	12:00:00	50
LHPS141	WENTWORTH MARINA-CENTER DOCK	06/23/2003	09:05:00	<10
LHPS147	WENTWORTH MARINA-WESTERN MOST DOCK	06/23/2003	09:02:00	<10
LHPS148	WENTWORTH MARINA-EASTERN MOST DOCK	06/23/2003	09:10:00	10
LHPS141	WENTWORTH MARINA-CENTER DOCK	06/16/2003	11:25:00	20
LHPS147	WENTWORTH MARINA-WESTERN MOST DOCK	06/16/2003	11:20:00	20
LHPS148	WENTWORTH MARINA-EASTERN MOST DOCK	06/16/2003	11:30:00	<10
LHPS141	WENTWORTH MARINA-CENTER DOCK	07/07/2003	09:25:00	20
LHPS147	WENTWORTH MARINA-WESTERN MOST DOCK	07/07/2003	09:20:00	<10
LHPS148	WENTWORTH MARINA-EASTERN MOST DOCK	07/07/2003	09:30:00	<5
LHPS141	WENTWORTH MARINA-CENTER DOCK	08/11/2003	09:37:00	50
LHPS147	WENTWORTH MARINA-WESTERN MOST DOCK	08/11/2003	09:30:00	<10
LHPS148	WENTWORTH MARINA-EASTERN MOST DOCK	08/11/2003	09:45:00	70
LHPS141	WENTWORTH MARINA-CENTER DOCK	08/18/2003	08:29:00	10
LHPS147	WENTWORTH MARINA-WESTERN MOST DOCK	08/18/2003	08:23:00	30
LHPS148	WENTWORTH MARINA-EASTERN MOST DOCK	08/18/2003	08:35:00	20
			Average	**30.8**

The volume of water in the marina is known from DES (2001). Therefore, assuming complete mixing each day, the daily loading rate from boats in the marina can be estimated to be approximately 6,100 billion org/year. Table B6 shows the calculation used to estimate this loading rate.

Table B6: Estimated annual loading from boats in the marina based on fecal coliform measurements

	Value	Units	Source
Area	4.80E+05	ft	NHDES (2001)
Depth	10	ft	NHDES (2001)
Volume	1.36E+08	L	Calculated
FC Concentration	30	cts/100ml	Average FC in 2003
Daily FC Load	4.08E+01	bill org/day	Calculated
Season Duration	150	d	6/1 to 10/31
Annual FC Load	6,117	bill org/year	Calculated

The estimated load from Table B6 was compared to the modeled load from the Watershed Treatment Model. The default assumptions in the Watershed Treatment model predicted an annual load of 52,700 bill org/year, which is eight times higher than the value predicted from field measurements. The WTM assumes that each boat is occupied 50% of the time during the summer season, which the model authors acknowledge to be very conservative. DES calibrated the model to more closely match local conditions by reducing the assumed occupancy rate to 10%. With this change, the WTM model predicted an annual load for the marina to be 8,700 billion org/year (Table

B7), which is a reasonable match to the estimated load in Table B6. Therefore, the default assumption for the boat occupancy rate was changed from 50% to 10%. Note that the model default value for fecal coliforms in raw sewage (10,000,000 cts/100ml) was used because there should be no attenuation during delivery with boat discharges.

Table B7: Modeled fecal coliform loads from boats in the marina and mooring field

Parameter	Marina	Moorings	Units	Source
Maximum Number of Boats	170	100	#	NHDES (2001)
Maximum Number of Boats with Heads	121	44	#	NHDES observations in summer 2003
Summer Season Duration	150	150	d	6/1 to 10/31
Summer Occupancy Rate	10%	10%	%	Assumption - based on field data
People per Boat	2	2	people	Default WTM Assumption
Wastewater Generation	8	8	gal/person/	Default WTM Assumption
Total Wastewater Generated	29,040	10,560	gal	Calculated
Wastewater Removed by Pumpout Boat	6,000	1,000	gal	2003 estimated pumpouts in Little Harbor
Wastewater Discharged	23,040	9,560	gal	Calculated
FC concentration in Wastewater	1.00E+07	1.00E+07	cts/100ml	Default WTM Assumption
Annual FC load	8,721	3,618	bill org/yea	Calculated
Total Annual FC Load for Marina and Mooring Field		12,339		

Table B8: Watershed Treatment Model inputs for the Little Harbor Bacteria TMDL

Assumptions	Berrys Brook	Sagamore Creek	Witch Creek	New Castle	Source
Land Use in Urbanized Areas (acres)					
Low Density Residential	475	675	29	7	MRLC Land Use Classes[1]
High Density Residential	7	10	0	0	MRLC Land Use Classes[1]
Commercial	167	263	3	0	MRLC Land Use Classes[1]
Forest	983	599	19	26	MRLC Land Use Classes[1]
Rural	5	38	0	11	MRLC Land Use Classes[1]
Open Water	14	36	0	9	MRLC Land Use Classes[1]
Subtotal	1,650	1,622	50	52	MRLC Land Use Classes[1]
Land Use in non-Urbanized Areas (acres)					
Low Density Residential	368	88	108	0	MRLC Land Use Classes[1]
High Density Residential	0	0	0	0	MRLC Land Use Classes[1]
Commercial	108	24	1	0	MRLC Land Use Classes[1]
Forest	2,074	269	314	7	MRLC Land Use Classes[1]
Rural	22	9	9	6	MRLC Land Use Classes[1]
Open Water	34	140	161	71	MRLC Land Use Classes[1]
Subtotal	2,606	529	593	84	MRLC Land Use Classes[1]
Total	4,256	2,151	643	136	
Number of dwelling units (#)					
In Urbanized Areas	1573	1345	33	28	US Census 2000[2]
In Non-Urbanized Areas	437	40	87	0	US Census 2000[2]
Fraction of dwellings on septic systems					
In Urbanized Areas	0.6	0.4	1.0	0.5	See note 3
In Non-Urbanized Areas	0.9	0.4	1.0	0.5	See note 3
Other Customized Assumptions					
Annual Rainfall			42	in.	NHDES (2001)
Average FC concentration in urban runoff			7,800	cts/100ml	LHTMDL data
Average FC concentration in discharge from illicit connections and failing septic systems			36,000	cts/100ml	Model calibration
Percent of boats occupied in marina			10	%	Model calibration

Notes

1. Land use classes for the WTM were calculated using the Multi-Resolution Land Characterization dataset from 1992 with the definitions shown in the following table. Each watershed was split into "urbanized areas" and "non urbanized areas" using shapefiles from the US Census 2000.

WTM Land Use Classification	MRLC Land Use Classification
Commercial	Commercial/Industrial/Transportation
Forest	Deciduous Forest, Emergent Herbaceous Wetlands, Evergreen Forest, Mixed Forest, Woody Wetlands
High Density Residential	High Intensity Residential
Low Density Residential	Low Intensity Residential, Urban/Recreational Grasses
Open Water	Open Water
Rural	Bare Rock/Sand/Clay, Orchards/Vinyards/Other, Pasture/Hay, Quarries/Strip Mines/Gravel Pit, Row Crops, Transitional

2. The number of dwellings was estimated by multiplying the number of dwellings in a census block by the fraction of the block inside the watershed in urbanized and non urbanized areas.

3. The fraction of dwellings without sewer service was estimated from a shapefile of parcels paying fees for sewer service to the City of Portsmouth and records of shoreline surveys by the DES Shellfish Program.