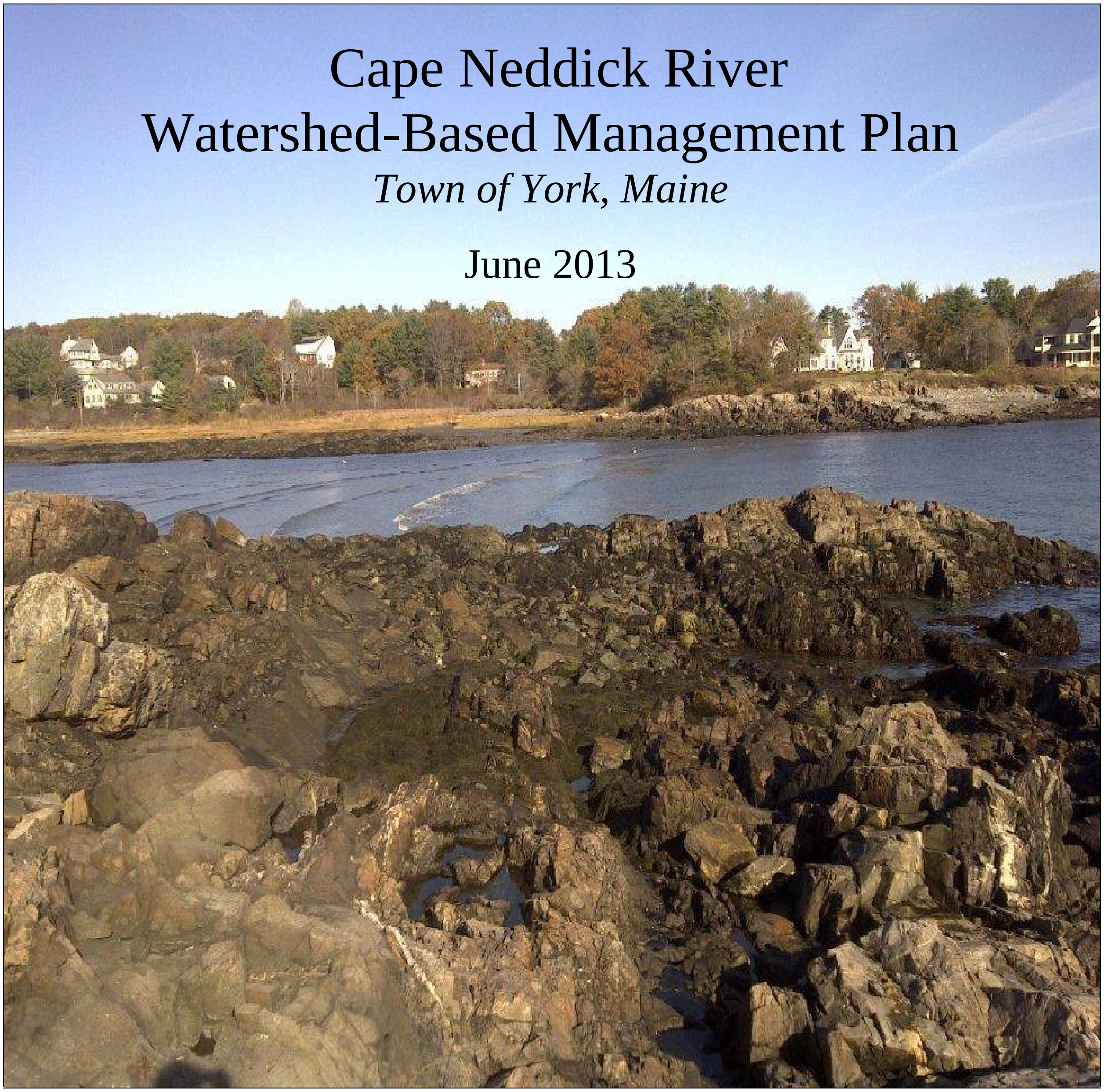
Cape Neddick River
Watershed-Based Management Plan

Town of York, Maine

June 2013



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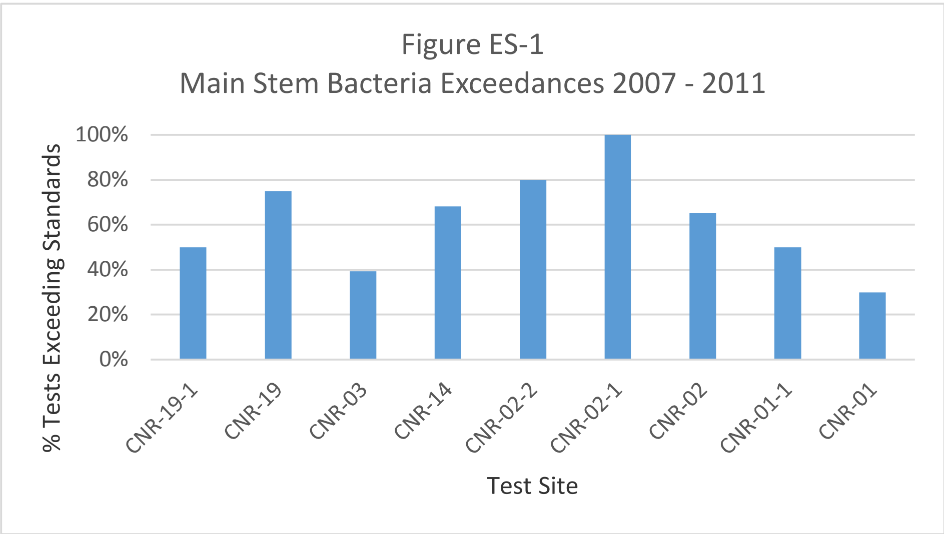
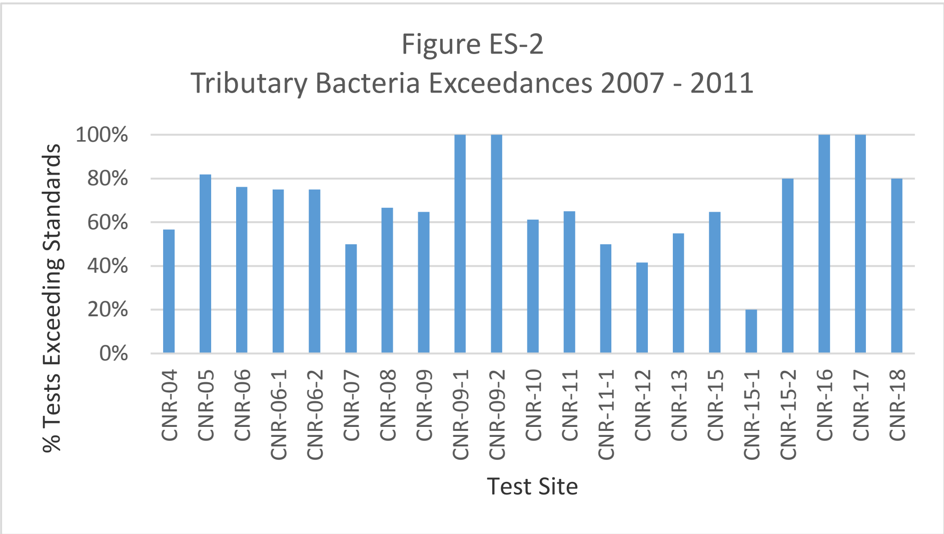
1. EXECUTIVE SUMMARY

This plan serves as a guide for the restoration and protection of water quality in the Cape Neddick River (CNR). The frequent exceedance of water quality standards, in conjunction with analyses that have indicated the watershed may be overbuilt and thereby affecting water quality, prompted the Town of York to initiate preparation of this watershed-based management plan (WBMP). Figures ES-1 and ES-2 show the percentages of water quality tests (2007-2011) in the main stem and tributaries of the CNR that exceeded standards for bacteria. Water quality testing at Cape Neddick Beach has also shown bacteria levels in excess of bacteria standards, although at a lower percentage (approximately 10% to 25% per year since 2007).





The elevated bacteria levels in the river have also attracted the attention of the Maine Department of Environmental Protection (MEDEP). Accordingly, the MEDEP has listed the estuary portion of the river as a water body impaired by bacteria, requiring that a total maximum daily load (TMDL) be developed for the estuary and an associated study prepared and approved by the Environmental Protection Agency (EPA). A TMDL study defines the maximum amount of pollutant each source in a watershed can contribute to a water body, so that the water body remains in compliance with applicable water quality standards. The EPA mandates that a WBMP be prepared for impaired water bodies requiring a TMDL.

Based on the water quality impacts described in this WBMP, the listing of the CNR Estuary as an impaired waterbody, and project requirements that have been specified by the Town of York, the following restoration goals have been established:

- Establish eligibility of the CNR watershed for Clean Water Act Section 319 nonpoint source (NPS) funding;
- Identify measures to restore impacted freshwater portions of the CNR to the Class B bacteria standard;
- Identify measures to restore estuarine waters to the Class SB bacteria standard;
- Identify measures to restore Cape Neddick Beach waters to the Coastal Beach bacteria standard;
- Include components to remediate river segments affected by non-bacteria pollution, where applicable; and
- Create a culture of collaboration and coordination between stakeholders.

This WBMP is focused on water quality and is not intended to be a comprehensive guide for protecting the overall environmental health of the CNR watershed. It is intended to be a dynamic guide for community restoration efforts in the watershed where the most significant water quality impacts have been identified by the various monitoring efforts conducted thus far.

Conceptual Model. Based on 2007-2011 water quality data, land use, and hydrology characteristics, three zones were identified for purposes of creating a conceptual CNR Watershed model and to guide future monitoring efforts.

- Zone 1 – Chase’s Pond to Hutchins Lane Bridge
- Zone 2 – Hutchins Lane Bridge to Shore Road Bridge
- Zone 3 – Seaward of Shore Road Bridge

Land use and water quality data suggest that Zone 1 may not make a large contribution to the bacteria loads encountered in the lower portion of the watershed. However, the northern tributary draining the west side of Route 1 may warrant further testing based on its proximity to more developed areas. In contrast to land use in Zone 1, Zone 2 is predominantly developed. Many of the tributaries with elevated bacteria concentrations are located in the lower portion of Zone 2, downstream of the Route 1 Bridge. Zone 3 includes Cape Neddick Beach and commercial areas located near the Shore Road Bridge. Only one small tributary flows into this reach of the river.

2012 Monitoring Program. In order to better characterize the CNR water quality, especially where bacteria levels are historically high, a targeted monitoring program was conducted in the summer of 2012. The following primary goals were identified for the 2012 monitoring program in order to provide data to supplement the existing historical database and to assist with identifying strategies to mitigate elevated bacteria levels.

1. Recognizing that from the ocean to the head-of-tide below the Route 1 bridge, tidal flushing is the predominant water input to the main stem of the river, the first goal was to collect samples that reflected the upland component of the river flow as much as possible. To do this, all samples were collected at or shortly after low tide, when the water reflected the maximum freshwater input.

2. The second goal was to specifically examine the influence that water flowing from the tributaries has on the water quality of the main stem of the river. The volume of tidal flow into and out of the river is very large in comparison to the estimated volume of freshwater input from the tributaries.

3. The third goal was to assess the potential influence from selected point source locations. The primary point source was the York Sewer District (YSD) treatment plant outfall, and a sampling point was added directly over the outfall. In addition, two new sampling locations were added between Shore Road and the ocean to gather data that might identify indirect inputs from the Cape Neddick Oceanside Campground.

Both bacteria and non-bacteria parameters (dissolved oxygen, nutrients, and metals) were evaluated during the 2012 monitoring program. The following bullets summarize significant results from the 2012 monitoring program.

- The 2012 data show that there are significantly higher bacteria concentrations in all sampling locations immediately after a rain storm, compared to times when there has been no recent precipitation.

- Main stem samples collected from the estuary more than 24 hours after a rain event had low bacteria concentrations. This suggests that the bacteria concentrations in the main tidal portion of the river, which has been identified as impaired by the MEDEP, can drop to low concentrations rapidly (within a few tidal cycles) after the end of the rain event.

- Two samples were collected directly over the YSD treatment plant outfall at low tide from the visible upwelling above the outfall. One sample had no detectable *Enterococci* and the other sample had a lower *Enterococci* concentration than the nearby locations in the CNR. Collectively, these data do not implicate the YSD treatment plant outfall as a significant contributor to the *Enterococci* concentrations in the CNR.

Six priority subwatersheds were selected based on historical water quality data and the results of the 2012 monitoring program. They are identified by their associated sampling location identifier as shown in Figures ES-3 and ES-4.

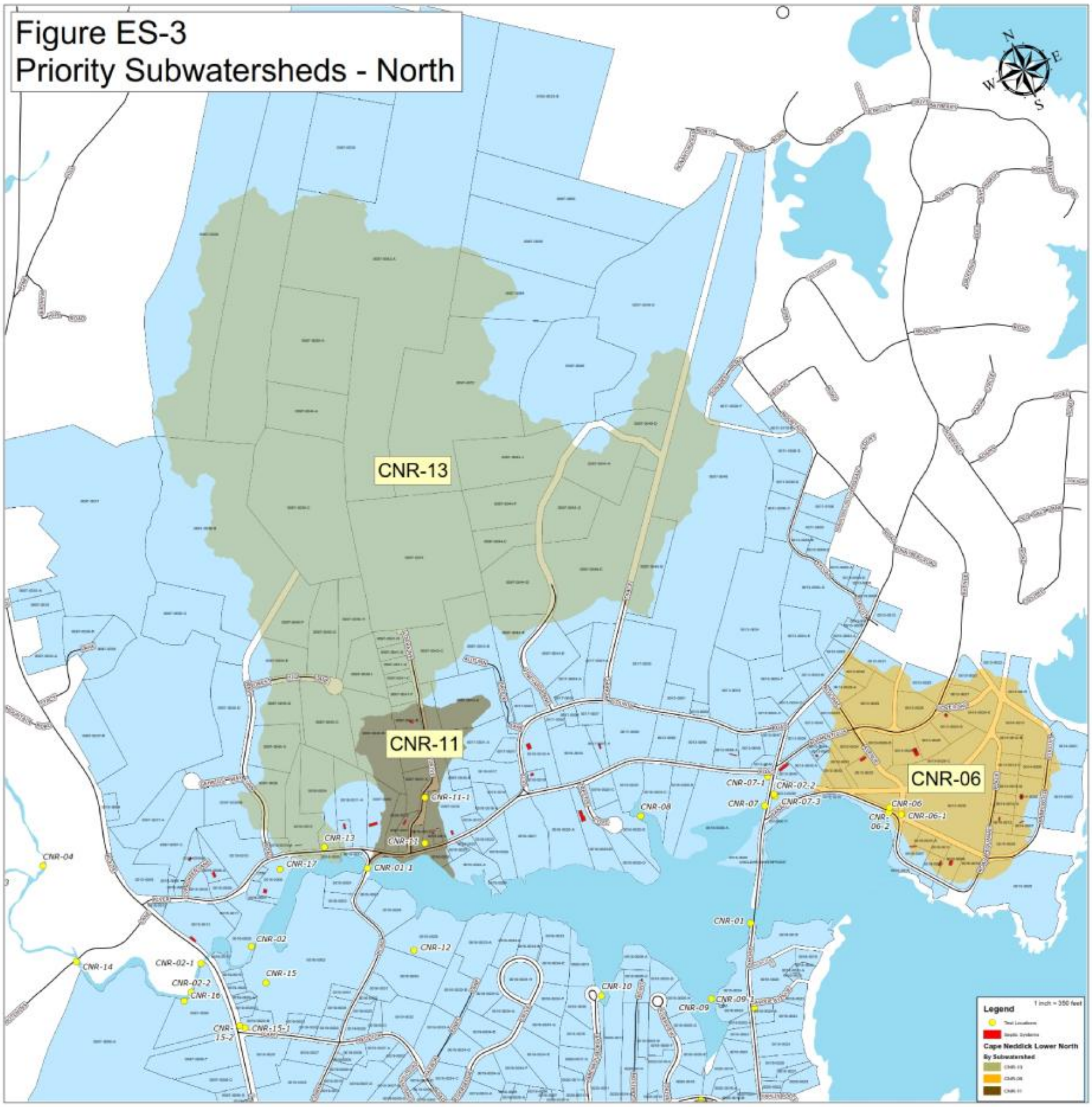


Figure ES-3
Priority Subwatersheds - North

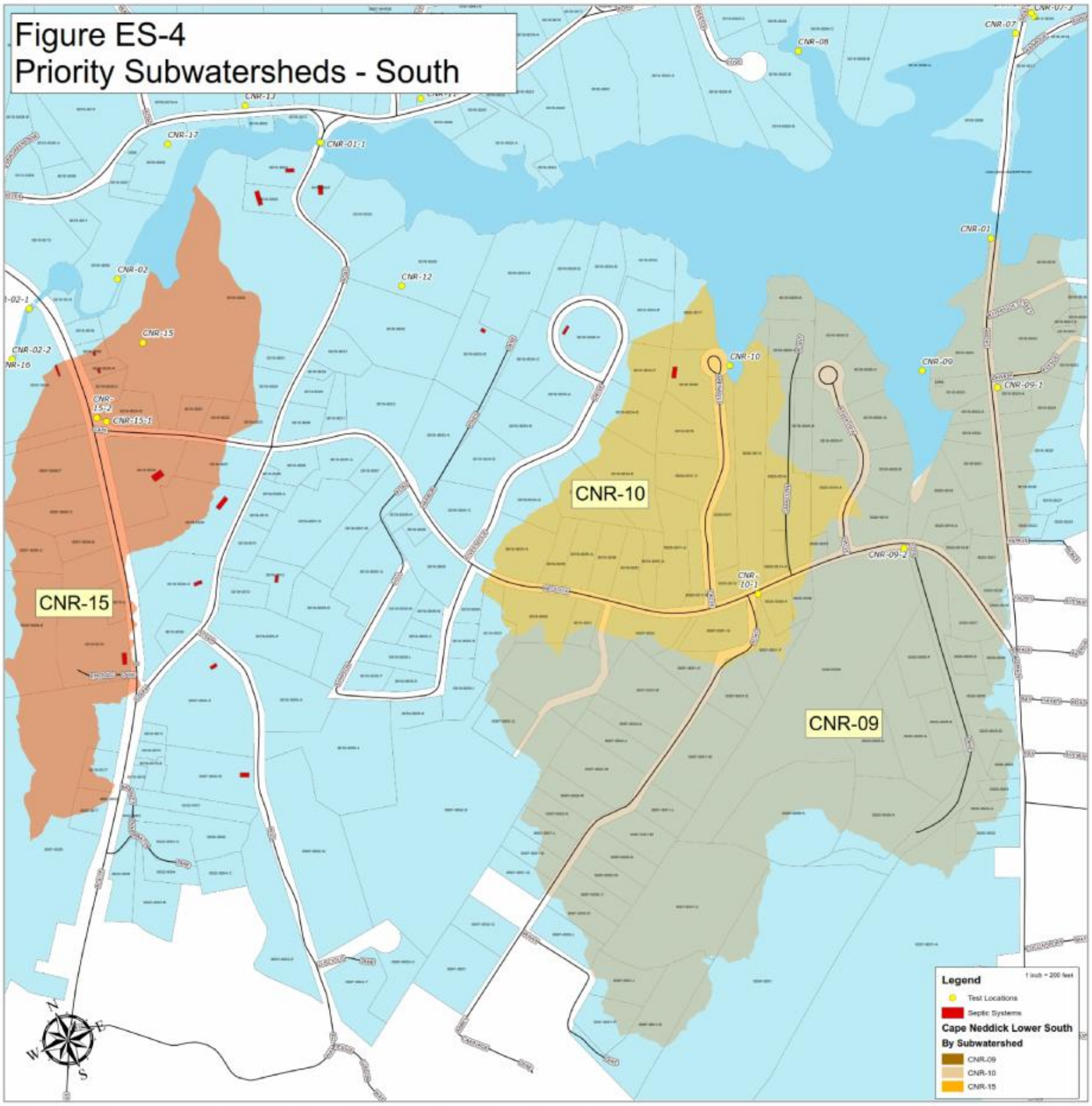


Figure ES-4
Priority Subwatersheds - South

Statistics associated with the level of development and the age of structures within each of the priority subwatersheds are shown in Table ES-1. The statistics were used for purposes of the TMDL study described below.

Table ES-1
Priority Subwatershed Statistics
Cape Neddick River

Statistic	CNR-06	CNR-09	CNR-10	CNR-11	CNR-13	CNR-15
Total Acres	46	90	33	17	249	34
Number of Houses	30	56	27	7	20	17
Average House Age	1976	1960	1964	1945	1986	1944
Acres of Built House Lots	31.17	66.26	32.58	8.23	80.86	22.23
Acres Per Built House Lot	1.04	1.18	1.21	1.18	4.04	1.31
Overall Density (Acres/ Houses)	1.53	1.61	1.22	2.43	12.45	2.00

TMDL Study. The TMDL study is intended to accomplish three major objectives:

1. Identify the bacteria sources within the study area.
2. Quantify the contribution from each bacteria source within the study area.
3. Determine the reduction from each human and domestic animal bacteria source required to meet the applicable TMDL for the CNR Estuary.

A statewide TMDL has been established for water bodies impaired by bacteria in Maine. Water quality standards applicable to Maine waters are used as the numeric water quality targets for bacteria TMDLs. Since the CNR Estuary is Class SB, the associated *Enterococci* bacteria standard serves as the applicable bacteria TMDL for the CNR Estuary. Accordingly, between May 15^{th} and September 30^{th}, *Enterococci* of human and domestic animal origin shall not exceed a geometric mean of 8 MPN/100ml or an instantaneous level of 54 MPN/100ml.

In a non-sewered watershed such as the CNR Watershed, potential sources of bacteria include failing septic systems, illegal dumping into the storm drain system, domestic animals, and wildlife. Although the CNR Estuary falls within the safety zone around the YSD treatment plant outfall, and there is the potential that untreated or partially treated sewage could be discharged into Cape Neddick Harbor in the unlikely event of a disruption at the treatment plant, it is not considered to be one of the sources contributing to exceedances of the bacteria TMDL in the estuary.

Bacteria load calculations were performed to estimate the bacteria loads discharging to the CNR Estuary from each of the priority subwatersheds, as well as the contribution of each bacteria source within the subwatersheds. The calculations were made on a subwatershed basis so that, combined with previous evaluations of water quality data, restoration work in the lower CNR could be further prioritized.

A Bacteria Source Load Calculator (BSLC) spreadsheet model (developed by the Center for TMDL and Watershed Studies at Virginia Tech) was used to estimate loads from the above identified bacteria sources including failing septic systems, domestic animals, and wildlife. Bacteria loads from illegal dumping into the storm drain system were not estimated since they can't be quantified. Because of the inaccuracies inherent in modeling watersheds, bacteria loads calculated by the BSLC model are only rough estimates. But by using the same methodology for modeling all the priority subwatersheds, the relative impact that each subwatershed and its associated bacteria sources have on the CNR Estuary can be evaluated.

Inspection of Figures ES-5 and ES-6 produced the following observations:

- CNR-09 potentially generates the overall largest bacteria load and the largest bacteria load from residential sources (i.e., failing septic systems and pet waste).
- CNR-13 potentially generates the second largest bacteria load but the majority of it is from forest sources (i.e., wildlife).
- CNR-06, CNR-10, and CNR-15 potentially generate similar bacteria loads, the majority of which are from residential sources.
- CNR-11 potentially generates the overall smallest bacteria load.
- Humans (i.e., failing septic systems) are potentially the largest source of bacteria loading to the estuary.
- Pets are potentially a significant contributor to overall bacteria loading to the estuary.

Figure ES-5
Estimated Fecal Coliform Loadings
Cape Neddick River Priority Subwatersheds

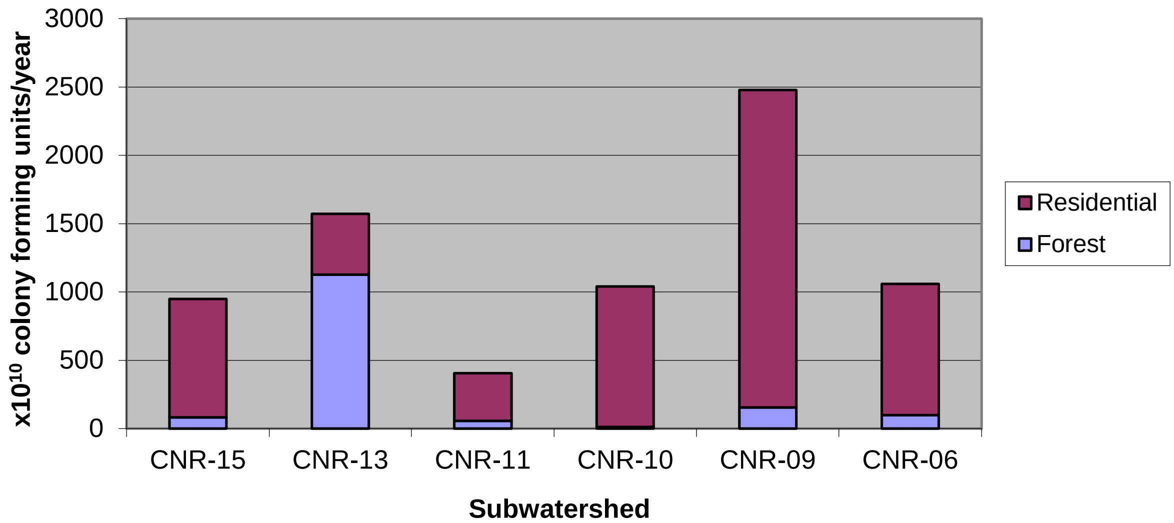
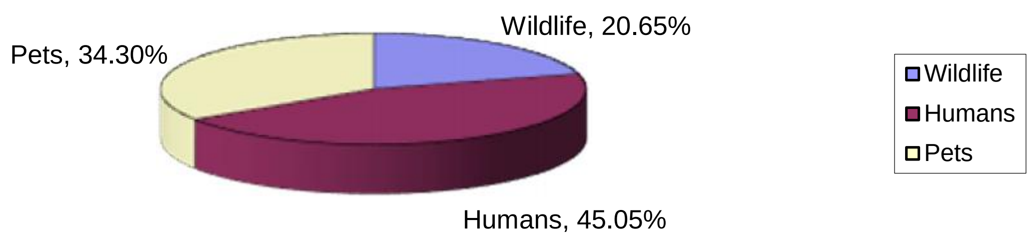


Figure ES-6
Estimated Percent Fecal Coliform Loading from Priority Subwatershed Sources



The following conclusions were drawn from the 2012 monitoring program and the TMDL study:

- The TMDL should be achievable during most of the regulated period between May 15th and September 30th when conditions are normally dry.
- Failing septic systems and pet waste appear to be the primary bacteria source in all the priority subwatersheds except CNR-13.
- Wildlife appears to be the primary bacteria source in CNR-13, with waterfowl likely a major direct contributor of bacteria to the estuary.
- The largest sources of human and pet bacteria appear to be associated with the three downstream priority subwatersheds (i.e., CNR-10, CNR-09, CNR-06), which is consistent with the trend of increasing *Enterococci* concentrations upstream to downstream during wet conditions.
- Bacteria mitigation measures will need to target all potential human and domestic animal sources in order to achieve the TMDL for the CNR Estuary under wet conditions.

Mitigation Measures. Six potential mitigation measures were identified for meeting the bacteria TMDL in the CNR Estuary as well as other water quality standards in freshwater portions of the CNR, the Estuary, and at the Cape Neddick Beach.

1. Identification and Replacement of Failing Septic Systems (MM-1)
2. Proper Maintenance of Septic Systems (MM-2)
3. Management of Pet Waste (MM-3)
4. Re-establishment of Vegetated Stream Buffers (MM-4)
5. Low Impact Development (LID) Retrofits (MM-5)
6. Sewer Extension to Lower CNR Neighborhoods (MM-6)

MM-1, MM-2, MM-3, and MM-6 would reduce and/or control bacteria at the source, while MM-4 and MM-5 would be designed to capture and treat bacteria carried in stormwater runoff. The mitigation measures were evaluated for effectiveness, implementability, and cost. Scores were assigned based on the evaluations and results are presented in Table ES-2. The scores are based on professional judgement and should only be used as a general guide when considering the relative merits of the mitigation measures and how their implementation should be prioritized.

Table ES-2
Bacteria Mitigation Measure Scores

Mitigation Measure	Effectiveness	Implementability	Cost	Overall Score
MM-1 and MM-2	4	4	2	10
MM-3	4	3	5	12
MM-4	2	3	4	9
MM-5	2	2	3	7
MM-6	5	3	1	9

Table ES-2 shows that MM-3 (Management of Pet Waste) scored the highest of the mitigation measures, largely because of its potential effectiveness and low cost. Accordingly, it should be given a high priority. The scoring also indicates that MM-1 and MM-2 received the highest score for reducing sources of human bacteria, and work on a septic survey should be initiated immediately to determine the actual scope of septic system failures within the priority subwatersheds. MM-6 would only be initiated in the event the septic survey finds that conditions are not favorable for septic system replacement, either because of field conditions or economic conditions, or both. The two treatment alternatives, MM-4 and MM-5, should be initiated as soon as willing landowners are identified. However, the emphasis should be placed on MM-4 not only because it is more easily implemented and has a lower cost, but because of the other benefits it can provide to both the landowner and the riparian habitat.

Section 12 of this WBMP includes a proposed schedule for phasing in mitigation measures, identifies milestones and decision points, defines the role of the public, and proposes methods for measuring the success or failure of mitigation measures. Sections 13 and 14 identify potential funding and technical assistance sources as well as potential lead organizations and agencies.

2. INTRODUCTION

2.1 Purpose of Plan

This plan serves as a guide for the restoration and protection of water quality in the Cape Neddick River (CNR). Seasonal water quality monitoring by the York Parks and Recreation Department (YPRD) at the Cape Neddick Beach and by the York Community Development Department (YCDD) at upstream locations has shown that bacteria levels at the beach and in the main stem and tributaries exceeded water quality standards on numerous dates over a span of several years. The frequent exceedance of water quality standards, in conjunction with analyses that have indicated the watershed may be overbuilt and thereby affecting water quality, prompted the Town of York to initiate preparation of this watershed-based management plan (WBMP). The elevated bacteria levels in the river have also attracted the attention of the Maine Department of Environmental Protection (MEDEP). Accordingly, the MEDEP has listed the estuary portion of the river as a water body impaired by bacteria, requiring that a total maximum daily load (TMDL) be developed for the estuary and an associated study prepared and approved by the Environmental Protection Agency (EPA). A TMDL study defines the maximum amount of pollutant each source in a watershed can contribute to a water body, so that the water body remains in compliance with applicable water quality standards. The EPA mandates that a WBMP be prepared for impaired water bodies requiring a TMDL.

This WBMP was designed so that it meets the overlapping requirements of the Town of York and the MEDEP and EPA. Town requirements include following EPA guidelines during preparation of the WBMP so that nonpoint source (NPS) pollution projects implemented in the watershed are eligible for federal funds under Section 319 of the Clean Water Act. These same guidelines are applicable to WBMPs that are used to apply for Section 319 funding for impaired water bodies requiring a TMDL. The following nine EPA criteria were followed during the preparation of this WBMP:

1. Identify the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the WBMP;
2. Estimate the load reductions expected from NPS management measures;
3. Describe the NPS management measures that will need to be implemented to achieve the identified load reductions;
4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the WBMP;
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the WBMP;
7. Describe interim, measureable milestones for determining whether NPS management measures or other control actions are being implemented;

8. Identify a set of criteria for determining if load reductions are being achieved and progress is being made towards attaining water quality standards, and if not, the criteria for determining if the WBMP needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

The above criteria will be referenced at appropriate places in this WBMP to show where they have been followed.

Section 319 of the Clean Water Act contains the NPS Management Program. Through that program, States, Territories and Native American Tribes can receive grant monies for a variety of NPS-related projects, including the restoration of water bodies impaired by NPS pollution. The program is administered by MEDEP in Maine. MEDEP annually selects projects from a pool of applications based in part on the status of a water body and the amount of NPS pollution that could ultimately be controlled or mitigated by a project. Grant monies have been used extensively on impaired and unimpaired but threatened water bodies in the State of Maine, from NPS pollution surveys to engineered treatment systems that separate NPS pollution from stormwater runoff. Projects do not necessarily need to directly reduce the amount of NPS pollution entering a water body to be eligible for grant monies, but can include activities associated with raising public awareness about NPS pollution such as “septic socials”, where the public is educated about the proper care and maintenance of septic systems. One of the factors considered by MEDEP when evaluating applications for 319 grants is whether the affected water body has been designated a NPS Priority Watershed by the MEDEP. These are watersheds with known sources of NPS pollution that have either impaired or threatened water quality. They are generally considered to be the watersheds most eligible for 319 grants. Although the Cape Neddick River is not currently designated a NPS Priority Watershed, recent communications with the MEDEP indicate that the river is currently receiving serious consideration during MEDEP’s review of NPS Priority Watersheds (Hoppe, 2013).

This WBMP is focused on water quality and is not intended to be a comprehensive guide for protecting the overall environmental health of the CNR watershed. The goals include the restoration and protection of water quality, which by extension consider the impacts of land development, but does not consider aspects unrelated to water quality such as viewsheds, terrestrial wildlife habitat, and public access. Issues related to the overall watershed health have been raised, and strategies offered, in a report prepared by the Wells National Estuarine Research Reserve (WNERR, 2003).

Finally, this WBMP is intended to be a dynamic guide for community restoration efforts in the watershed where the most significant water quality impacts have been identified by the various monitoring efforts conducted thus far. Future monitoring efforts may identify other areas of the watershed needing restoration, and the guidance provided in this WBMP should in no way limit the types of remedies applied to those areas. Additionally, follow-on work associated with water quality monitoring and/or the design of NPS mitigation measures proposed in this plan may need to be modified where private property concerns or conditions on the ground require it. This plan is the starting point for water quality restoration in the watershed, and it is expected that additional ideas and concepts will be developed as the work progresses.

2.2 Tasks Associated with Plan Development

The following tasks were completed over the course of plan development:

- Baseline Assessment – The project team conducted a comprehensive review of all available water quality and land use data collected by various organizations prior to the start of this project.
- Involve Stakeholders – Stakeholder meetings were held at the beginning, middle, and end of this project in order to share information with stakeholders and to gather their input.
- Conduct Water Quality Testing – The project team, with the assistance of Town staff, conducted water quality testing during the 2012 summer season for bacteria and non-bacteria parameters in the main stem and the tributaries of the river.
- Estimate Bacteria Load and Calculate Load Reduction Target – Specific subwatersheds were modeled for their output of human, domestic pet, and wildlife bacteria loads to the river. Load reductions to the appropriate water quality target were estimated.
- Identify High Priority Sources – Through data collected from water quality monitoring and the results from modeling output from bacteria sources, high priority subwatersheds were identified.
- Develop Bacteria Mitigation Measures – Mitigation measures that targeted the suspected sources of human and domestic animal bacteria were developed.
- Propose Strategies for Measuring Effectiveness – Strategies for measuring the effectiveness of bacteria mitigation measures through water quality monitoring and implementation of mitigation measures have been proposed.

2.3 Restoration Goals

Based on the water quality impacts described in this plan, and project requirements specified by the Town of York, the following restoration goals have been established:

- Establish eligibility of the CNR watershed for Clean Water Act Section 319 NPS funding;
- Identify measures to restore impacted freshwater portions of the CNR to the Class B bacteria standard;
- Identify measures to restore estuarine waters to the Class SB bacteria standard;
- Identify measures to restore Cape Neddick Beach waters to the Coastal Beach bacteria standard;
- Include components to remediate river segments affected by non-bacteria pollution, where applicable; and
- Create a culture of collaboration and coordination between stakeholders.

3. WATER QUALITY OVERVIEW

Separate standards apply to freshwaters, the estuary, and beaches within the CNR Watershed. This section identifies the regulatory classification for each of those waters, lists the numeric standards for each classification, and provides a narrative of how water quality in the CNR compares to the standards.

Freshwater. The freshwater portions of the CNR are classified as Class B and, as such, "must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as unimpaired." Table 3-1 shows that *E. coli* bacteria are used as an indicator of potential public health risk in Class B waters, and monitoring conducted by the YCDD during the 2009 summer season showed that the standard for *E. coli* was exceeded at freshwater sampling locations on numerous occasions, indicating that some of the tributaries are not suitable for recreation in the water, such as children playing in the water. Monitoring using *Enterococci* as a substitute indicator bacteria at some of those same locations during other years (i.e., 2007, 2008, 2010, 2011, and 2012) also suggests that freshwaters are unsuitable for recreation in the water. Dissolved oxygen (DO) concentrations met the applicable summer standard in the majority of the tributaries during early season high flows. However, as freshwater flows decreased over the summer, the DO concentration fell below the standard in many of the tributaries. Low DO is undesirable and potentially presents a threat to some aquatic organisms.

Table 3-1
Numeric Standards for Cape Neddick River Waters

Waterbody Class	Dissolved Oxygen Standard	Bacteria Standard
Class B (freshwater)	Between May 15th and September 30th: Not less than 7 parts per million or 75% of saturation, whichever is higher. Between October 1st to May 14th in identified fish spawning areas: The 7-day mean dissolved oxygen concentration may be not be less than 9.5 parts per million and the 1-day minimum dissolved oxygen concentrations may not be less than 8.0 parts per million.	Between May 15th and September 30th: *E. coli* of human and domestic animal origin shall not exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 236 per 100 milliliters.
Class SB (salt/brackish)	Not less than 85% of saturation.	Between May 15th and September 30th: Enterococcus of human and domestic animal origin shall not exceed a geometric mean of 8 per 100 milliliters or an instantaneous level of 54 per 100 milliliters.
Coastal Beach	None	Between May 15th and September 30th: Failure results from single sample enterococcus level exceeding 104 per 100 milliliters or a geometric mean of 35 per 100 milliliters for five samples within a 30-day period.

Sources: 38 MRSA Ch.3 §464 & 465
National Shellfish Sanitation Program Manual of Operations, Part I, Sanitation of Shellfish Growing Areas, USFDA

Estuary. The CNR estuary is classified as Class SB and, as such, "must be of such quality that it is suitable for the designated uses of recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation and as habitat for fish and other estuarine and marine life. The habitat must be characterized as unimpaired." Table 3-1 shows that *Enterococci* bacteria are typically used as an indicator of potential public health risk in Class SB waters and monitoring during the 2007-2011 summer seasons showed that the standard for *Enterococci* was exceeded at estuary sampling locations on several occasions, depending on the year. More controlled monitoring during the 2012 summer season showed that *Enterococci* was exceeded at main stem sampling locations within the estuary only after storm events, when higher flows from the tributaries and overland stormwater runoff was a strong influence on the composition of estuary waters. The monitoring data indicates that the estuary may not be suitable for recreation in the water, such as swimming, during the approximately 24-hour period following storm events. DO levels in the main stem generally met the applicable summer standard. Although fecal coliform standards exist for shellfish growing areas in estuaries and marine waters, shellfish harvesting is permanently prohibited in the CNR estuary because of the safety zone that has been assigned around the YSD outfall. Additionally, the Department of Marine Resources (DMR) no longer monitors for fecal coliform in the prohibited area.

Cape Neddick Beach. The Cape Neddick Beach is classified as a Coastal Beach and, as such, is subject to water quality standards for recreation in the water. Similar to the Class SB standard that has been applied to the estuary, Table 3-1 shows that *Enterococci* bacteria are used as an indicator of potential public health risk at coastal beaches. However, the Coastal Beach standard for *Enterococci* is considerably higher than the standard for Class SB waters, consequently, it is less conservative. The YPRD has been monitoring water quality at the beach using protocol developed by the Maine Healthy Beaches Program since 2003. Maine Healthy Beaches compiles the data and continues to oversee the program. Although less stringent than the Class SB standard for bacteria, the Coastal Beach standard was still exceeded at the Cape Neddick Beach on a sufficient number of occasions to raise concern. When the standard is exceeded, an advisory is posted and the beach water resampled on the following day. Although storm events were not specifically targeted for beach sampling, the data indicates that stormwater runoff has a significant influence on bacteria levels at the beach. High bacteria levels were often observed shortly after storm events (similar to the estuary monitoring) but usually receded to below the standard when the beach water was resampled on the following day.

Although there are no standards for phosphorus and nitrogen in CNR waters, they were monitored to determine if polluted runoff from potential sources such as lawn fertilizer or failing septic systems could be affecting water quality. If present in sufficient concentrations, they could contribute to the lowering of DO in the water column. Phosphorus and nitrogen concentrations are generally low in the main stem and the majority of the tributaries. Somewhat elevated concentrations were measured on a few of the tributaries, but the levels do not indicate that nutrients pose a threat to water quality.

4. DESCRIPTION OF THE WATERSHED

4.1 Watershed Overview

The following overview of the watershed and the river's journey to the sea was taken from Watershed Conservation Strategies: Cape Neddick River Watershed (WNERR, 2003). A map of the entire watershed is provided in Figure 4-1.

"The Cape Neddick Watershed is entirely in the Town of York beginning on the forested slopes of Mt. Agamenticus. The main stream and numerous tributaries are dammed to form the two mile long Chase's Pond. From the dam, the river travels southeast for a short distance, then turns to the northeast after flowing under the Maine Turnpike. It continues in this direction through forested landscape for about a mile, where it gently bends back to flow southeast, meeting a few small tributaries over the course of its journey. One major tributary from the north converges with the river shortly before it flows under Route 1 where it encounters a more developed landscape while coming under the influence of the tides. The tidal portion then gradually widens until its flow is restricted by the bridge crossing on Shore Road, after which it again widens and empties into the Gulf of Maine between Weare Point and Cape Neddick."

Some watershed facts taken from that same document and the York Comprehensive Plan Natural Resources Chapter (York, 2007) include:

- Total watershed area is approximately 6,660 acres;
- Watershed encompasses 16% of the area of York;
- River headwaters are impounded at Chase's Pond (capacity of nearly 1 billion gallons when full) for public water supply;
- Chase's Pond Watershed area is approximately 2,090 acres of which the York Water District (YWD) owns 1,834 acres or 88% of the watershed area;
- Estuary portion of river can vary from 600 feet wide and 10 feet deep at high tide to 20 feet wide and just a few feet deep at low tide; and
- York Sewer District (YSD) treatment plant outfall is located near the mouth of the river.

4.2 Community Resources

4.2.1 Public Water Supply. The YWD intake at Chase's Pond currently feeds most of the Town of York's public water supply. Two recently constructed distribution system interconnections and associated pump stations link the YWD to the Kennebunk, Kennebunkport, and Wells Water District to the north and the Kittery Water District to the south. They provide the three Districts with back-up water supply in case of a water emergency in any of the areas serviced by those districts.

The YWD operates the Josiah Chase Filtration Plant located off Chase's Pond Road. The Plant has the capacity to treat 4 million gallons per day (MGD) but typically operates at much lower flow rates. An average of 0.95 MGD of water was withdrawn from Chase's Pond and treated in 2011 (YWD, 2012). The Plant is designed to meet all primary and secondary drinking water standards. Water test results for 2011 (most recent annual report available on their website)

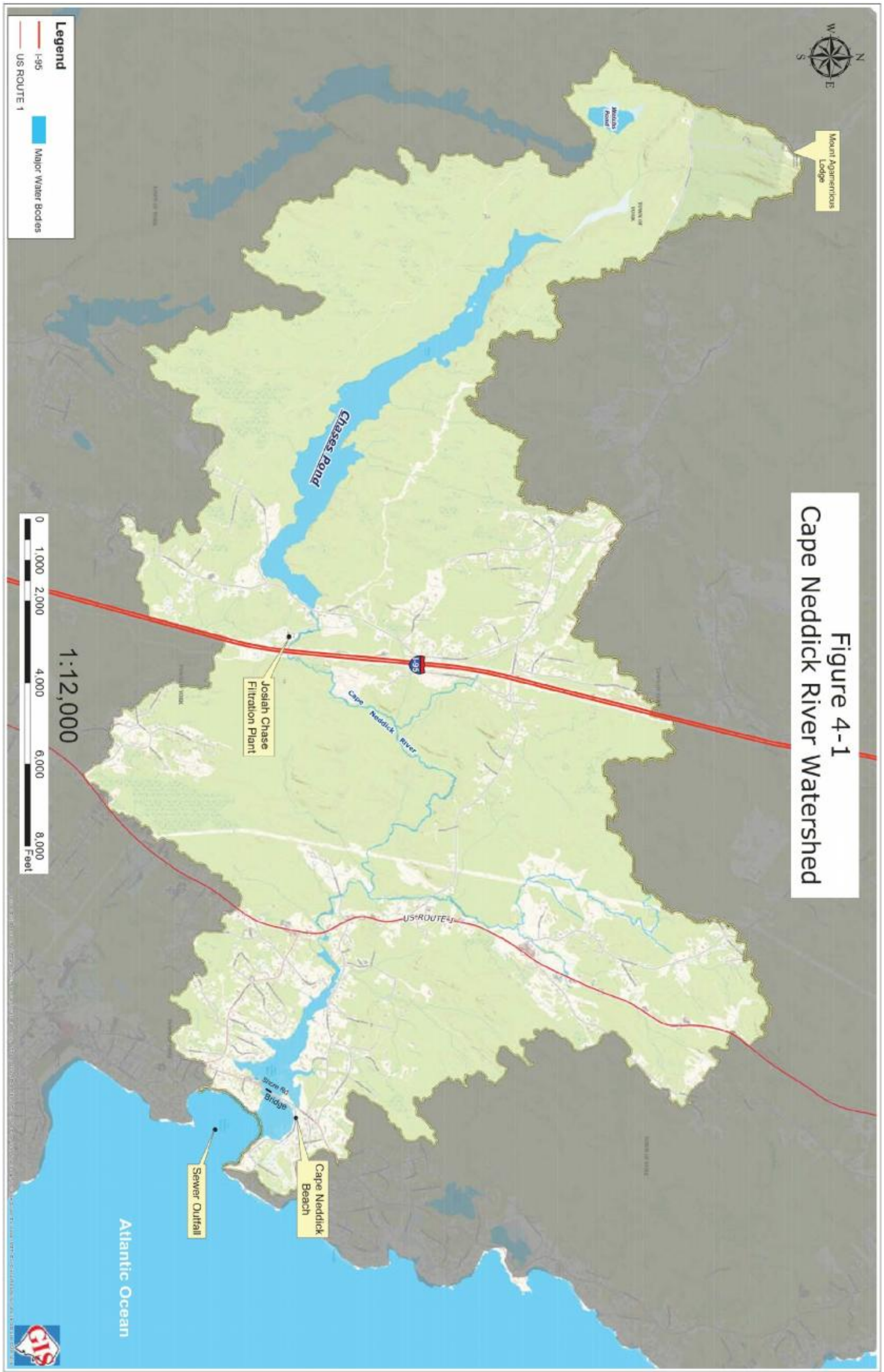


Figure 4-1
Cape Neddick River Watershed
Legend
I-95
US ROUTE 1
Major Water Bodies
1:12,000
0 1,000 2,000 4,000 6,000 8,000 Feet
Mount Agamenticus Lodge
Chases Pond
Josiah Chase Filtration Plant
Cape Neddick River
US ROUTE 1
Shore Rd Bridge
Cape Neddick Beach
Sewer Outfall
Atlantic Ocean

showed that levels of all contaminants monitored during that period were below the maximum contaminant levels allowed in drinking water. There were no water quality violations in 2011.

4.2.2 Wastewater Treatment Plant. The YSD treatment plant is located on the south shore of Cape Neddick Harbor. The plant was upgraded in 1994 to provide treatment for an average flow of 3.0 MGD and a peak flow of 7.5 MGD. It incorporates a secondary treatment process to treat the incoming wastewater. Chlorination is used from May 15th to September 30th in order to disinfect the effluent and eliminate potential pathogens. The secondary treatment process is designed to break down the various components in the incoming waste such that over 90% of the biochemical oxygen demand (BOD) and 90% of the total suspended solids (TSS) are removed. The Annual Treatment Performance Summary for 2012 showed that the average monthly BOD removal rate ranged from 92.5% to 97.4% and the average monthly TSS removal rate ranged from 94.2% to 97.8% (YSD, 2013). The permit issued by the MEDEP requires an 85% removal rate for BOD and TSS influent concentrations 200 milligrams per liter (mg/l) and greater. There were no violations of the required BOD and TSS removal rates in 2012. Fecal coliform bacteria tests on the plant effluent from May 15th to September 30th yielded monthly geomean concentrations ranging from 1.09 Most Probable Number (MPN)/100 milliliters (ml) to 2.48 MPN/100ml, well below standards used for approved shellfish growing areas. Average daily flow ranged from 0.84 MGD in November to 1.59 MGD in June. Average daily flow during the summer months (June – August) ranged from 1.21 MGD to 1.59 MGD. Effluent discharged from the plant enters Cape Neddick Harbor through a 10-meter long diffuser attached to the end of the outfall pipe. At low tide, approximately 15 feet of water covers the diffuser. In 2012, the YSD superintendent received the Charles Perry Award for "excellence in operations and maintenance of wastewater collection systems." The YSD also received a Certificate of Achievement for 2012 from the MEDEP to recognize 11 years of continuous improvement in all aspects of the district's operations.

4.2.3 Beach and Boat Launch. The Cape Neddick Beach is a small, locally popular beach located near the mouth of the river (see Figure 4-1). Extensive tidal flats are associated with the beach, and the distance between swimmable water depths at high tide versus low tide extends over several hundred feet. There is very limited parking on the road bordering the beach and there are no restrooms or other facilities. On the south shore of the river, just upstream of the Shore Road Bridge, there is a private boat launch facility located at the Cape Neddick Lobster Pound Restaurant. Navigation in this part of the river is limited to above mid tide.

4.3 Natural Resources

4.3.1 Greater Agamenticus Conservation Area. Approximately 50% of the watershed (3,300 acres) is located west of the Turnpike and falls within the Greater Mount Agamenticus Conservation Area (WNERR, 2003). This 33,000-acre, five-town conservation area, contains the highest diversity of species and the largest number of rare and endangered species in the state. It also includes some of the largest unfragmented (undivided by paved roads) coastal forest in the northeast between southern New Jersey and Acadia National Park. More than 2,000 acres of the largest block of unfragmented forest falls within the Cape Neddick River watershed. This area also includes a large mapped deer wintering area just south of Chase's Pond and over a dozen documentations of rare animal occurrences.

4.3.2 Shorebird Habitat. The estuary portion of the river contains important shorebird habitat for tidal waterfowl and wading birds. In 1986, a Maine Department of Inland Fisheries and Wildlife study done for the State Planning Office gave Cape Neddick River the highest rating for riparian habitat and waterfowl wintering area (WNERR, 2003).

4.3.3 Shellfishing. The tidal flats located in the estuary and at the mouth of the river provide prime habitat for a variety of shellfish species. Unfortunately, this area lies within a safety zone around the wastewater treatment plant outfall where the DMR has declared the digging, taking, or possessing of any clams, quahogs, oysters, or mussels from the shores, flats, and waters to be prohibited (DMR, 2008). The safety zone was created to protect public health in the unlikely event a disruption at the treatment plant caused untreated sewage to be released into Cape Neddick Harbor. The DMR enforces a safety zone around any "overboard discharge" that discharges treated sewage into marine waters.

4.4 Land Use and Land Cover

Land use is a description of the economic activity being conducted on the land. Land cover is a description of the physical features (natural and manmade) covering the ground. Land cover information is derived by satellite sensors' detection of changes in light reflection from the Earth's surface.

In the last 30 years, the Town of York as a whole has experienced one of the highest growth rates in the State of Maine. Approximately 68% of the parcels in York are utilized for residential use, and another 25% of the parcels are classified as being residential but undeveloped (York, 2004). Therefore, over 90% of the parcels are either in residential use or have the potential for residential use. Acreage figures break out differently, however, with a relatively reduced proportion of the land area for residential use and an increased proportion for utility use (e.g., watershed protection zone around Chase's Pond). Even then, residential remains the predominant land use in the Town of York with 69% of the total land area.

Land cover data shows 21% of the area of York as developed land (York, 2004). Not surprisingly, residential development accounts for the vast majority of the developed land. The majority of the land area in York is undeveloped, with forest being the most common land cover.

Route 1 divides the CNR Watershed approximately into two distinct land use patterns. The watershed east of Route 1, particularly on the southern side of the river, is relatively dense residential whereas the watershed west of Route 1 is more rural. There is presently no municipal sewer within the watershed, although the YSD wastewater treatment plant is located nearby on the southern shore of the Cape Neddick Harbor. Overall, the watershed is relatively free of heavy industrial development with only light to moderate commercial land use mostly located along the Route 1 corridor. The Cape Neddick Harbor, where the river enters the Gulf of Maine, houses roughly a dozen commercial fishing/lobster boats and approximately 30 pleasure craft.

Of the 6,660 acres in the watershed, 1,834 acres or about 27% is conserved, mostly through the efforts of the YWD (YWD, 2012). All of the conservation land is located west of Route 1 and all but 90 acres is west of the Turnpike. Both the Turnpike and Route 1 are major transportation

routes that cross the watershed. East of the Turnpike, there exists three blocks of land each greater than 500 acres and unfragmented by paved roads (WNERR, 2003). These blocks have been identified as representing an opportunity for conservation and/or development. If developed irresponsibly, they could present a risk to the watershed in terms of degradation of wildlife habitat and water quality.

4.5 Watershed Partners

Implementation of this WBMP will require coordination and cooperation between federal, state, county, and local organizations as well as the hundreds of homeowners living in the watershed. A list of likely watershed partners is provided in Appendix A.

4.6 Water Quality Monitoring Past and Present

Several organizations have conducted water quality monitoring on the CNR. Table 4-1 identifies some of the organizations, the years when they monitored, and the parameters that they analyzed.

Table 4-1
Cape Neddick River Water Quality Monitoring History

Year	York Conservation Commission[1]	Department of Marine Resources[2]	University of New Hampshire[3]	Parks and Recreation Department[4]	Community Development Department[5]
1995		Fecal Coliform			
1996	Fecal Coliform	Fecal Coliform			
1997	Fecal Coliform	Fecal Coliform			
1998	Fecal Coliform	Fecal Coliform			
1999		Fecal Coliform			
2001		Fecal Coliform			
2002		Fecal Coliform	E. coli		
2003		Fecal Coliform		Enterococci	
2004		Fecal Coliform		Enterococci	
2005		Fecal Coliform		Enterococci	
2006				Enterococci	
2007				Enterococci	Enterococci
2008				Enterococci	Enterococci
2009				Enterococci	Enterococci, E. coli, Optical Brightener
2010				Enterococci	Enterococci, Optical Brightener
2011				Enterococci	Enterococci, Optical Brightener
2012				Enterococci	Enterococci

Notes: [1] Sampled four locations (Hutchins Lane Bridge to Shore Road Bridge) during summer months.
[2] Sampled three locations near mouth of CNR.
[3] Sampled two locations (Hutchins Lane Bridge and Shore Road Bridge) during a single rain storm.
[4] Sampled two locations (Cape Neddick Beach and Shore Road Bridge) during summer months.
[5] Sampled up to 27 locations during summer months.

5. BASELINE ASSESSMENT OF PRE-2012 WATER QUALITY DATA

5.1 Previous Water Quality Data Summaries

As summarized in Table 4-1, water quality in the CNR has been monitored by the Town and other groups since the 1990s. This section provides a brief summary of previous water quality data, focused primarily on the data collected by the YCDD since 2007 and YPRD since 2003. Maine Healthy Beaches (MHB) provides technical support for both these programs and has maintained the databases.

5.1.1 YCDD Data Summary. An overview of sampling locations used by YCDD since 2007 is as follows:

- During 2007, water was sampled from five locations along the CNR, primarily along the main stem of the river between the Maine Turnpike and the ocean (CNR-01 to CNR-05). Sample CNR-01 was located in the tidal portion of the river at Shore Road. CNR-02 and CNR-03 were along the freshwater portion of the main stem of the river. CNR-04 and CNR-05 were on tributaries in the upper watershed.
- In 2008, the sampling expanded to 10 additional tributary locations (designated CNR-06 to CNR-15) and continued in 2009.
- In 2010, sampling focused on locations CNR-01, -04, -09 and -10.
- In 2011, sampling locations were expanded higher up into several tributaries.

Figure 5-1 shows the locations where water quality samples were collected from 2007 to 2011. Tabulated data from these sample seasons are included in Appendix B.

The 2007 to 2011 water quality data show that many of the sampling locations had bacteria concentrations that frequently exceeded bacteria standards. Figures 5-2 and 5-3 show the percentage of main stem samples and tributary samples, respectively, that exceeded EPA *Enterococci* bacteria standards of 61 MPN/100ml in freshwater (for 2007, 2008, 2010, and 2011) and 104 MPN/100ml in saltwater (2007 – 2011) (EPA, 1986). During 2009, the EPA *E. coli* standard of 236 MPN/100ml was used for freshwater tests. These bacteria standards are less conservative (i.e., higher numeric value) than the applicable CNR standards presented in Table 3-1, so the percentage of exceedances shown in Figures 5-2 and 5-3 would actually be higher if the Table 3-1 standards for fresh and saltwater were applied.

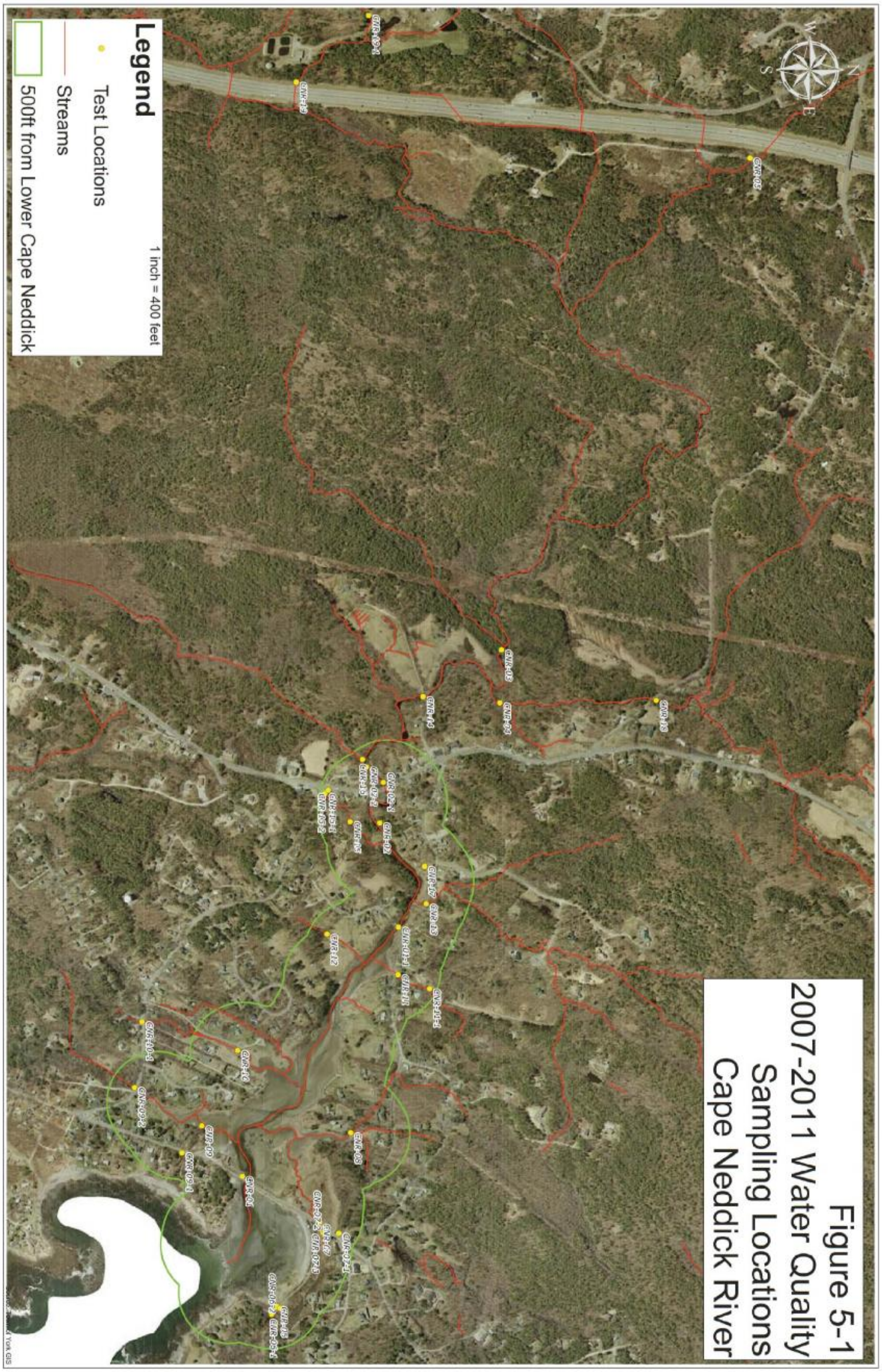
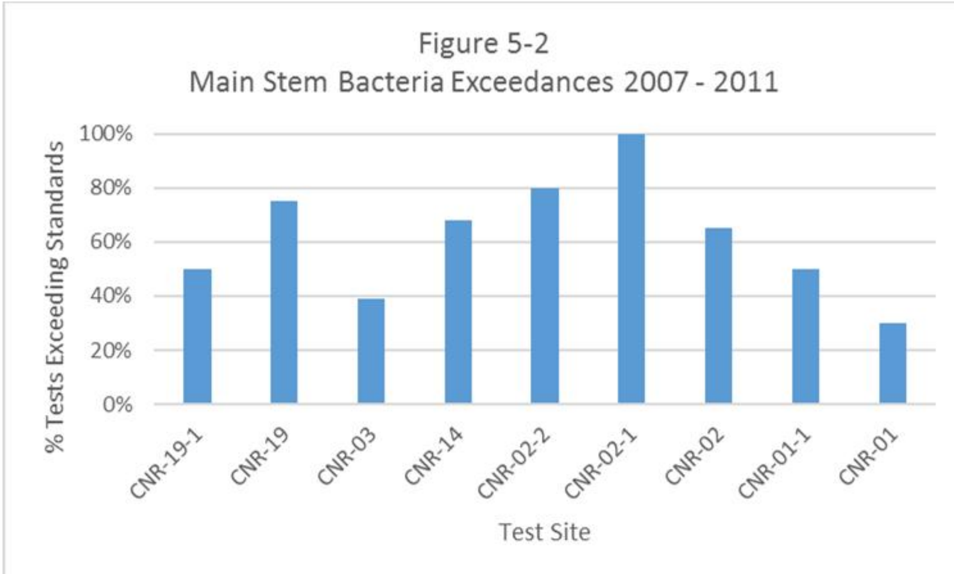
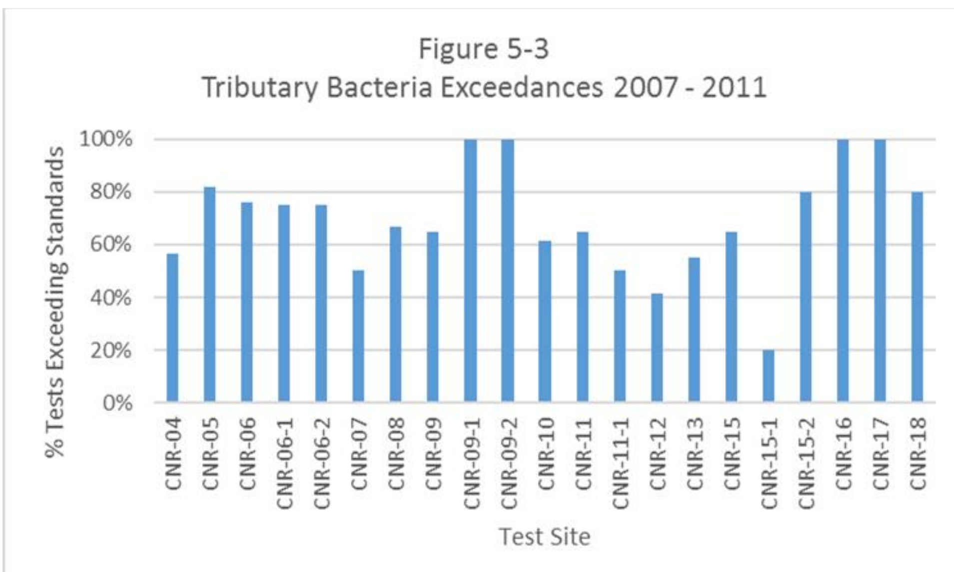


Figure 5-1
2007-2011 Water Quality
Sampling Locations
Cape Neddick River
Legend
Test Locations
Streams
500ft from Lower Cape Neddick
1 inch = 400 feet





A general overview of these data is provided below. As indicated in the sampling location overview, some locations were sampled during only one season (e.g., CNR-19 and CNR-19-1 in 2011) so conditions for that year may have biased test results from those samples as compared to locations that were sampled over several years.

- Figure 5-2 indicates that, downstream of CNR-03, there is a generally increasing trend in the percentage of tests exceeding bacteria standards in the main stem of the river as it approaches developed areas in the vicinity of Route 1, and a generally decreasing trend as

the river enters the estuary. Dilution of bacteria concentrations in the incoming freshwater by tidal influences is likely responsible for the decreasing trend in the estuary.

- Figure 5-3 shows a high percentage of tests exceeding bacteria standards in nearly all tributaries. Only two tributary test locations had a percentage less than 50% (CNR-12 and CNR-15-1). Except for CNR-05, the test locations with the highest percentages (80% and greater) were tested only during 2011.

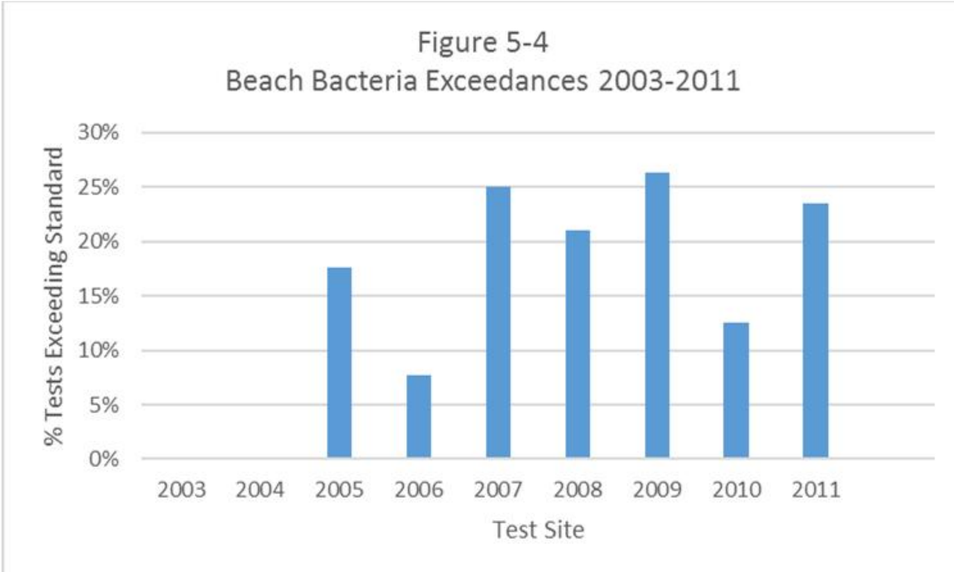
- Review of the overall water quality database indicates wet weather is an important factor associated with elevated concentrations of bacteria. During sampling events that followed precipitation, bacteria concentrations tended to be higher than during drier periods, particularly in the tributaries.

- Water samples from the main stem of the river at Shore Road (CNR-01) were below the standard the majority of sampling rounds in 2007, 2009, 2010 and 2011 and 70% overall between 2007 and 2011. Most of the samples that exceeded the standard were collected shortly after a rain event.

- During 2011, additional samples were collected on tributaries CNR-06, -09, -11, and -15 at points where the tributaries either branched or at points above and below specific potential bacteria source areas. Some of the new subsampling locations provided an indication that one branch of a tributary had consistently higher levels than another branch. Other data were inconclusive. Perhaps the most successful subsampling was along the CNR-15 tributary, where the eastern branch (CNR-15-1) had only one sample that exceeded the bacteria standard while the western branch (CNR-15-2) had 4 samples that exceeded this value.

5.1.2 YPRD Data Summary. The YPRD has been monitoring water quality at Cape Neddick Beach (and Shore Road Bridge) each summer since 2003. Beach sampling follows MHB protocol.

Figure 5-4 shows the percentage of samples annually that exceeded the *Enterococci* bacteria standard of 104 MPN/100ml from 2003 to 2011. This is the same standard as that listed for Coastal Beaches in Table 3-1. A general overview of these data is provided below.



- Review of the overall beach database indicates that rainfall and runoff appear to be a major contributor to bacteria exceedances, but significant rainfall did not result in high bacteria concentrations in every case. Tidal influences may mitigate the effects of bacteria in runoff in some cases.

- Test results from several of the years showed that some bacteria exceedances coincided with relatively low salinity in the sample, indicating that the sample was collected when stormwater runoff was dominating estuary chemistry. The highest recorded bacteria concentration was 24,196 MPN/100ml on July 14, 2010, when the salinity was 3 as opposed to an average of around 31.

- No bacteria exceedances occurred in 2003 and 2004. This may have been due in part to the fact that 2003 was the driest year since 2000. However, 2004 was the fourth wettest year since 2000, so the test results may have been more influenced by sample collection timing which just happened to avoid runoff from storm events.

- The trend appears to be an overall increase in exceedances of the bacteria standard at Cape Neddick Beach.

Previous Non-Bacteria Water Quality Data.

In comparison to the extensive database of bacteria data, water quality data on other parameters is limited for the CNR. The most comprehensive data set was collected by MHB and EPA in 2008. The 2008 data includes samples collected in June, July and August from the majority of the 15 CNR sampling locations. Water analyses included dissolved oxygen (DO) and the nutrients nitrogen and phosphorus, which have the potential to promote algae growth that degrades water quality.

Review of this non-bacteria water quality data indicated that overall, the water quality of the CNR was good. The main stem of the river (CNR-01, CNR-02 and CNR-03) had generally high DO and low concentrations of nitrate and phosphorus, except a nitrate concentration above 1 mg/l in CNR-01 in the June sample.

Water quality data from the tributaries summarized below exhibited low DO or somewhat elevated concentrations of nitrate or phosphorus.

- CNR-06 had low DO and somewhat elevated phosphorus in most samples;
- CNR-07 had one low DO reading, one elevated nitrate reading, and two elevated phosphorus readings;
- CNR-08 had some slightly elevated nitrate readings and one elevated phosphorus reading;
- CNR-10 had two elevated nitrate readings;
- CNR-11 had one elevated phosphorus reading; and
- CNR-12 had two elevated nitrate and one elevated phosphorus readings.

5.2 Other Relevant Reports

A number of other water quality reports have been generated that include data from the CNR. Data from these reports (noted below) have been reviewed and were valuable in developing a strategy for conducting additional sampling in 2012 and in evaluating the 2012 water quality data.

- In 1995, the Wells Reserve and MEDEP commissioned a study of DO and circulation in several southern Maine estuaries, including the CNR (Kelly and Libby, 1996). The study found fairly high DO concentrations in the CNR. The study also developed circulation and tidal flushing data for the estuary that have been used in this WBMP for comparison with estimated flows from tributaries in the lower CNR.

- In 2001, the Town commissioned a built-out analysis that included the lower portions of the CNR watershed (RKG Associates, Inc., 2001). This analysis included estimation of the land capacity to accommodate septic systems and identified the lower CNR Watershed as an area where further study is warranted to evaluate water quality.

- In 2003, Dr. Stephen Jones of the University of New Hampshire (UNH) reported on a ribotyping analysis he had conducted to evaluate the potential source of bacteria in two water samples collected from the CNR (Jones, 2003). Based on his analysis, the water sample collected at the Shore Road Bridge contained *E. coli* from birds, wildlife and pets. A water sample collected just downstream of the Hutchins Lane Bridge contained bacteria from humans, birds, wildlife, pets and livestock.

- During 2011, Dr. Kim Borges from the University of Maine at Fort Kent collaborated with the MHB program to collect and analyze water samples using DNA-based microbial source tracking (Borges, 2012). Three sample locations from the CNR (CNR-06, CNR-06-2 and CNR-13) were included in the study. The data indicated human-related bacteria at CNR-06 and CNR-06-2, but no human-related bacteria in water collected at CNR-13.

6. CONCEPTUAL WATERSHED MODEL

Based on a review of the extensive data collected prior to 2012 and outlined in Sections 3, 4, and 5, a conceptual watershed model of the CNR was developed to frame the 2012 sampling strategy. The conceptual model considered a variety of factors including the water quality data, land use characteristics, and the hydrology of the watershed below the Chase's Pond Dam.

The historical water quality data indicated that elevated bacteria concentrations could be detected at any of the sampling locations over the course of a summer season. The data indicated that bacteria concentrations were higher shortly after a rain event in all locations. The current land use in the watershed includes majority undeveloped land above Route 1 and majority developed land below Route 1. The hydrology of the watershed is also characterized by a high density of tributaries that drain developed land in the lower watershed.

In addition to the water quality data, a watershed-scale assessment was performed of the relative contribution of freshwater input to the tidal estuary. The method of Dudley ("Estimating Monthly, Annual, and Low 7-Day, 10-Year Streamflows for Ungaged Rivers in Maine", USGS Scientific Investigations Report 2004-5026) cited in the MEDEP Chapter 587 surface water flow rules was used to develop an estimate of the total average freshwater flow from the watershed on a monthly basis. This monthly average river flow volume was compared to the tidal flushing volume calculated by the MEDEP as part of their 1995 DO study (Kelley and Libby, 1996). The results of this assessment indicate that monthly freshwater inputs from the watershed into the estuary range from a maximum of approximately 6% in March to less than 1% in June, July, August, and September (Figure 6-1). Logically, since this assessment was done for the entire watershed downstream of the Chase's Pond Dam, the input from any of the tributaries is much smaller as a percentage. While this comparison of potential freshwater flow versus tidal flushing is quite generalized, it does point out that there is a large amount of dilution of the freshwater input every tidal cycle and this is likely to strongly influence water quality in the tidal portions of the CNR.

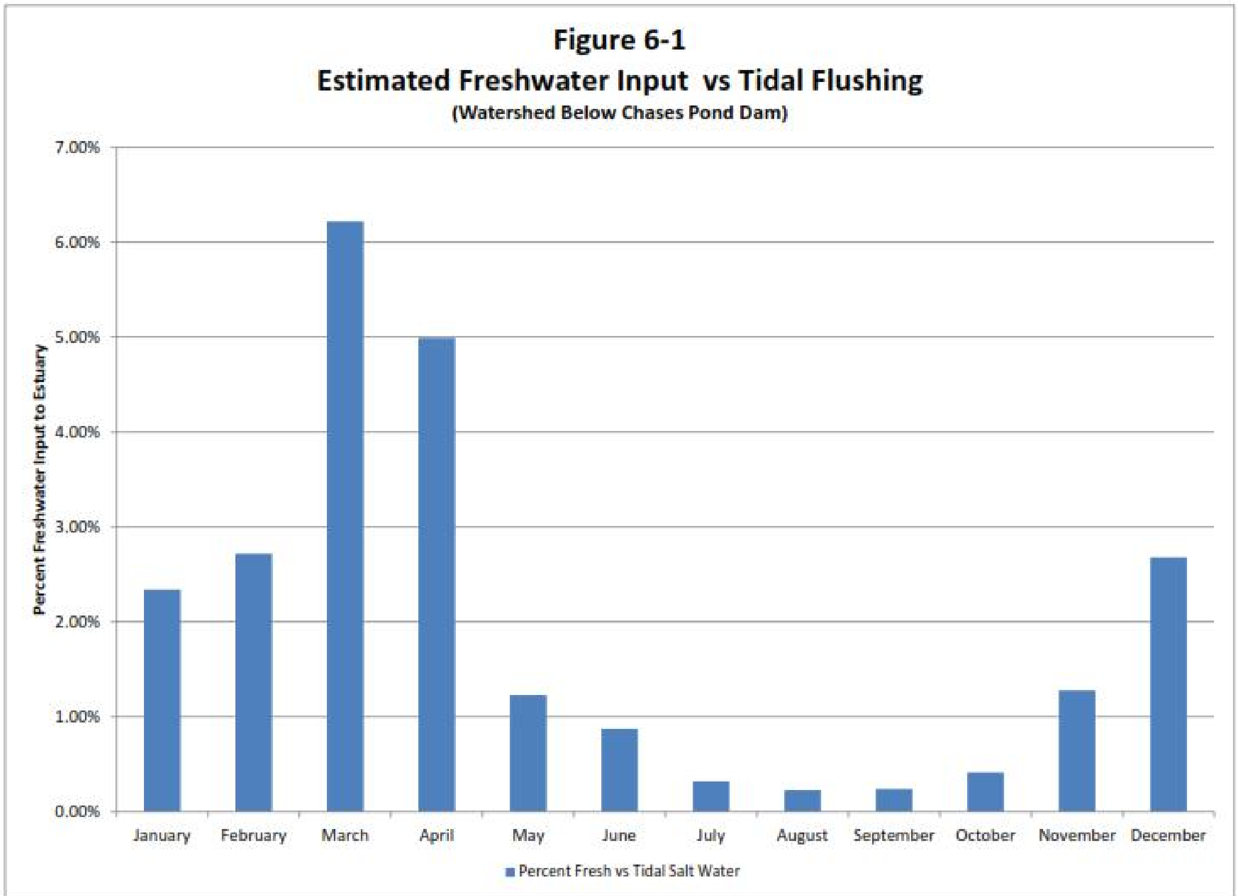
The water quality, land use, and hydrology characteristics were used to identify the three zones described below.

6.1 Zone 1 – Chase's Pond to Hutchins Lane Bridge

The majority of the land upstream of Hutchins Lane is wooded with some areas of low density residential development. There are a number of single family houses and a few small residential neighborhoods in this portion of the watershed. But in comparison to the land use below Hutchins Lane, the predominant characteristic of Zone 1 is rural. A potentially significant exception is the subwatershed associated with the tributary that drains the west side of Route 1 and joins the main stem between CNR-03 and Hutchins Lane. CNR-04 and CNR-18 are located on this tributary.

Water quality data from Zone 1 locations include a number of samples with elevated bacteria concentrations. Therefore, there may be a potential to improve water quality with further evaluation and mitigation. However, water from the CNR-03 location, near the downstream end

of Zone 1, had a low percentage of samples exceeding bacteria standards (see Figure 5-2) compared to most other locations. These data suggest that the portion of the watershed above CNR-03 may not make a large contribution to the bacteria loads encountered in the lower portion of the watershed. However, the northern tributary draining the west side of Route 1 may warrant further testing based on its proximity to more developed areas and relatively elevated *Enterococci* levels recorded at CNR-18 in 2011.



6.2 Zone 2 – Hutchins Lane Bridge to Shore Road Bridge

In contrast to the land in Zone 1, the land from Hutchins Lane to the Shore Road Bridge is predominantly developed. Many of the tributaries with elevated bacteria concentrations are located in this lower portion of the watershed.

From Hutchins Lane to the CNR-02 sampling location, the river is fresh water. From just downstream of CNR-02 to Shore Road, the main stem of the river is tidal and varies in salt content depending on the stage of the tide. The sampling locations at CNR-07, -08, -09 and -10 are below the high tide line and can be fresh or brackish. Sampling locations at CNR-06, CNR-11, CNR-12, CNR-13 and CNR-15 are above the high tide line and are fresh water.

6.3 Zone 3 – Seaward of Shore Road Bridge

From Shore Road to the ocean, the river varies dramatically from a 5- to 10-foot wide channel with wide sand bars on either side at low tide, to fully submerged with sea water at high tide. CNR-06 is the only tributary sampling location that flows into this reach of the river.

7. SUMMER 2012 FIELD INVESTIGATION

7.1 Goals and Approach

Three primary goals were identified for the 2012 sampling in order to provide data to supplement the existing historical database and to assist with identifying strategies to mitigate elevated bacteria levels. Figure 7-1 shows the locations where water quality samples were collected in the lower river in 2012.

1. Recognizing that from the ocean to the head-of-tide just downstream of CNR-02, tidal flushing is the predominant water input to the main stem of the river, the first goal was to collect samples that reflected the upland component of the river flow as much as possible. To do this, all samples were collected at or shortly after low tide, when the water reflected the maximum freshwater input.

Figure 7-1
2012 Sampling Locations
Lower Cape Neddick River

2. The second goal was to specifically examine the influence that water flowing from the tributaries has on the water quality of the main stem of the river. The volume of tidal flow into and out of the river is very large in comparison to the estimated volume of freshwater input from the tributaries. To develop a better understanding of the influence

that individual tributaries have on the main stem water quality, two new sampling locations were added along the main stem of the river below CNR-02. Location CNR-01-3 was added near the head of tide, just downstream of the confluence with CNR-15. Location CNR-01-2 was added near the old railroad trestle and is located downstream of tributary inputs from CNR-11 and CNR-12.

3. The third goal was to assess the potential influence from selected point source locations. The primary point source was the YSD treatment plant outfall, and sampling point YK-A3 was added directly over the outfall. In addition, two new sampling locations were added between Shore Road and the ocean (YK-A1 and YK-A2) to gather data that might identify indirect inputs from the Campground.

7.2 Testing Activities

During 2012, sampling was conducted on four dates in May, June, July and September. Samples from the main stem of the river were collected at low tide consistent with the first goal outlined above. Representatives from Watershed Solutions, Drumlin, and Frick Associates assisted Town staff during the May sampling round. Town staff conducted the remainder of the sampling.

The sampling on May 9, 2012 was conducted a few hours after a rain event where the Cape Neddick weather monitoring station measured 0.86 inches of rain. There was no rain during the days before the June 12 and July 7 sampling events. The September 6 sampling event was preceeded by 0.75 inches of rain, mostly on September 4, but no rain fell within the 24-hour period before samples were collected.

Sampling was conducted in each of the three zones described above in Section 6.

- Zone 1: Samples were collected from CNR-03, CNR-04, CNR-05 and CNR-19. A new sampling location designated CNR-05-D was added immediately downstream of the former dump.

- Zone 2: Samples were collected from CNR-02, CNR-01-3, CNR-01-1, CNR-01-2 and CNR-01 along the main stem of the river (upstream to downstream). Tributary samples were collected in Zone 2 from CNR-15, CNR-13, CNR-12, CNR-11, CNR-10, CNR-09, CNR-08 and CNR-07.

- Zone 3: Samples were collected from YK-A1 and YK-A2 in the main channel, YK-A3 over the YSD treatment plant outfall and from the tributary CNR-06.

During all sampling events, the water was analyzed in the field for temperature, specific conductance (salinity), and DO. Samples from all locations except CNR-03 and CNR-04 were analyzed for *Enterococci* during all events. During the May and July sampling events, selected samples were also analyzed for non-bacteria parameters including nitrate, total kieldahl nitrogen, total phosphorus and 13 heavy metals.

7.3 Non-Bacteria Test Results

Select water samples were analyzed for nutrients (nitrogen and phosphorus) and heavy metals during the May and/or July sampling events. The locations were selected after reviewing the 2008 data described in Section 5.2. Non-bacteria data are presented in Appendix C and discussed below.

In general, the nitrate concentrations were lower than reported in 2008, when several samples had reported concentrations of greater than 1 mg/l. The total phosphorus concentrations were also lower than reported in 2008. Only 2 samples had detectable phosphorus at concentrations slightly above the detection limit.

The majority of the 13 priority pollutant heavy metals were not detected in the water samples. Low concentrations of copper, lead, nickel and zinc were detected. The copper, lead and/or zinc concentrations of some of the samples are slightly above the aquatic water quality criteria. However, these elements also occur naturally at trace concentrations in soil. The low levels detected and the absence of 9 of the 13 heavy metals suggests that these compounds are more likely to be natural in origin, rather than the result of specific land use activities.

The water samples collected downstream of the former dump (CNR-05-D) do not indicate significant waste-related input to the stream for either nutrients or heavy metals. Dissolved oxygen and specific conductance (SC)/salinity ware similar to the CNR-05 sample collected upstream of the dump.

DO was measured in all water samples as part of the 2012 sampling protocol. As noted earlier in Table 3-1, freshwater portions of the CNR are designated as Class B water, which have a DO concentration standard of 7 mg/l or 75% of saturation. Brackish and salt portions of the river are designated Class SB, which has a DO concentration standard of 85% saturation.

The DO data collected during 2012 are summarized in Table 7-1. DO concentrations were typically at or above the classification concentration along the main stem of the river in the lower (brackish and salt) reaches, although the DO dipped below these levels in two samples collected near Shore Road in the September samples. Tributaries to the Zone 2 portion of the river all had DO concentrations above the classification values in the May sampling event. In June, three tributaries had dropped below the DO target values. In July, two tributaries were dry and two had dropped below the DO target values. In September, one tributary was dry and six had low DO concentrations. In the Zone 1 tributaries, DO values were above the target concentrations in May, June and July, and dropped below the target concentration in September.

The DO data from the CNR tributaries indicate that as summer progresses, there are a number of locations where the concentrations drop below the classification standards. This is likely to be partly, and perhaps mostly, the result of decreasing flow in many tributaries. As flow decreases there is less mixing and more quiescent flow and/or stagnant conditions.

Table 7-1
Dissolved Oxygen Data – 2012
Cape Neddick River

Sample	Date			
	5/9/2012	6/12/2012	7/10/2012	9/6/2012
MAIN STEM				
CNR-02				
Fresh/Salt	F	F	F	F
DO	10.3/93	10.3/93	**6.51/--**	**5.99/--**
CNR-01-3				
Fresh/Salt	F	F	S	S
DO	10.3/93.0	9.18/96.54	10.41/--	9.86/--
CNR-01-1				
Fresh/Salt	F	B	S	F
DO	11.86/106.3	9.67/101.2	10.75/--	NR/98.2
CNR-01-2				
Fresh/Salt	**B**	S	S	S
DO	11.57/103.6	**6.29/71.3**	7.81/108.6	**5.43/58.0**
CNR-01				
Fresh/Salt	S	S	S	S
DO	10.79/97.9	8.55/95.5	7.3/100.7	**5.94/75.7**
YK-A1				
Fresh/Salt	S	S	S	S
DO	10.83/98.7	**5.49/63.3**	8.11/103.8	**6.36/80.1**
YK-A2				
Fresh/Salt	S	S	S	S
DO	10.8/98.9	7.01/85.5	8.43/105.1	7.66/95
YK-A3				
Fresh/Salt	S		S	
DO	11.0/--	NS	8.24/103.5	NS
ZONE 2 TRIBS				
CNR-15				
Fresh/Salt	F	F	F	F
DO	9.9/90.8	8.41/84.38	7.55/--	**5.82/--**
CNR-13				
Fresh/Salt	F	F	F	F
DO	11.70/104.5	8.51/85.1	9.35/--	7.8/--
CNR-12				
Fresh/Salt	F	F	Dry	Dry
DO	10.38/91	**6.96/68.3**	NS	NS
CNR-11				
Fresh/Salt	F	F	F	F
DO	10.89/97.4	8.54/85.69	7.4/--	**4.76/--**

Sample	Date			
	5/9/2012	6/12/2012	7/10/2012	9/6/2012
ZONE 2 TRIBS				
CNR-10				
Fresh/Salt	F	F	S	S
DO	9.09/81.5	7.31/73.1	**4.5/54.5**	**5.53/61.2**
CNR-09				
Fresh/Salt	S	S	S	S
DO	10.29/96.7	16.87/143	7.34/101.6	7.22/79.5
CNR-08				
Fresh/Salt	F	B	S	S
DO	11.54/103.7	8.71/90.78	7.83/--	**6.08/--**
CNR-07				
Fresh/Salt	B	B	S	S
DO	8.71/80.0	**2.95/29.2**	**2.97/45.3**	**1.6/22.9**
CNR-06				
Fresh/Salt	F	B	Dry	B
DO	5.0/45.3	**0.16/1.48**	NS	**0.57/6.5**
ZONE 1 LOCATIONS				
CNR-19				
Fresh/Salt	F	F	F	F
DO	10.3/98.2	8.25/88.6	7.08/--	**6.88/--**
CNR-05				
Fresh/Salt	F	F	F	F
DO	10.6/95.3	8.29/82	9.22/--	**5.23/--**
CNR-05-D				
Fresh/Salt	F	F	F	F
DO	10.3/92.9	NS	8.56/--	NS
CNR-03				
Fresh/Salt	F	F	F	F
DO	10.89/99.5	9.12/93.6	7.85/--	NS
CNR-04				
Fresh/Salt	F	F	F	F
DO	11.02/98.8	8.18/83.3	9.30/--	NS

Notes:
1. DO is listed as "X/Y" with "X" = concentration in mg/L. "Y" is %.
2. "--" = Parameter Not Measured. NS = No Sample Collected.
3. F = Fresh, S = Salt, B = Brackish.
4. Highlighted values are below the applicable DO Criteria

7.4 Bacteria Test Results

As described earlier in Sections 5 and 6, there are historical data showing elevated bacteria concentrations in the CNR. The purpose of the 2012 sampling was to gather specific data to evaluate the goals outlined in Section 7.1, including assessing specific potential sources (e.g., the YSD treatment plant outfall) and evaluating the impact of the freshwater tributaries on the bacteria concentration in the tidal portion of the main stem.

The bacteria data from the four 2012 sampling events are summarized in Table 7-2. The data from May and July have also been summarized in two graphs (Figures 7-2 and 7-3) to provide a graphic depiction of the bacteria concentrations in the main stem and tributary samples from below Route 1 to the ocean. As described above in Section 7.2, the May sampling occurred at the end of a rain storm and the other sampling events occurred either during dry periods or at least 24 hours after rain had ended.

Table 7-2
Bacteria Data – 2012
Cape Neddick River

		ENTEROCOCCI			
Sample	Fresh/	*(MPN/100ml)*			
Designation	Salt	**5/9/2012**	**6/12/2012**	**7/10/2012**	**9/6/2012**
MAIN STEM					
CNR-19	F	52	20	41	20
CNR-02	F	**545**	20	10	20
CNR-01-3	S	**259**	20	20	20
CNR-01-1	S	**341**	20	41	20
CNR-01-2	S	**397**	10	<10	<10
CNR-01	S	**443**	20	10	<10
YK-A1	S	**563**	10	<10	<10
YK-A2	S	**657**	<10	<10	<10
YK-A3	S	**146**	NA	<10	NA
ZONE 2 TRIBUTARIES					
CNR-15	F	**63**	52	31	**410**
CNR-13	F	**228**	**63**	**96**	41
CNR-12	F	**423**	20	Dry	dry
CNR-11	F	**888**	41	**74**	**193**
CNR-10	S	**130**	41	**115**	74
CNR-09	S	**473**	<10	10	<10
CNR-08	S	52	10	10	10
CNR-07	S	**181**	<10	10	10
CNR-06	S	**504**	**>24196**	Dry	**510**

ZONE 1 TRIBUTARIES					
CNR-05	F	**181**	20	20	**195**
CNR-05-D	F	**95**	NS	**62**	NS

Notes: 1. "<10" = No Enterococci Detected above detection limit of 10 MPN/100ml
2. USEPA Bacteria criteria for recreational waters = 104 MPN/100ml for salt water & 61 MPN/100ml for fresh water (for an individual sample).
3. Maine Class SB criteria for Enterococci = 54 MPN/100ml (individual sample).
4. BOLD values exceed USEPA &/or Class SB Criteria

The 2012 data provide additional information about the nature of bacterial concentrations in the CNR as summarized below.

- The 2012 data show that there are significantly higher bacteria concentrations in all sampling locations immediately after a rain storm (i.e., May 2012) compared to times when there has been no recent precipitation (i.e., June and July 2012).

- The September 2012 samples were collected more than 24 hours after a rain event, however the samples from the main stem of the river had low bacteria concentrations. This suggests that the bacteria concentrations in the main tidal portion of the river, which has been identified as impaired by the MEDEP, can drop to low concentrations rapidly (within a few tidal cycles) after the end of the rain event.

- Sample location YK-A3 was located directly over the YSD outfall and samples were collected at low tide from the visible upwelling above the outfall. Wave action on the beach prevented sampling over the outfall in June and September. However, the July sample had no detectable *Enterococci* and the May sample had a lower *Enterococci* concentration than the nearby locations in the CNR. Collectively, these data do not implicate the YSD treatment plant outfall as a significant contributor to the *Enterococci* concentrations in the CNR.

- Sample location CNR-06, which flows out of the marsh behind the Cape Neddick Beach, consistently shows elevated bacteria concentrations. The June sample, which was collected from a very small flow, had extremely high concentrations, which may have been due to entrained sediment in the sample. Despite the elevated bacteria concentrations at CNR-06, the small flow from this marsh does not appear to routinely raise main stem concentrations during dry conditions.

- Several sampling sites were located in the upper portion of the watershed (Zone 1). Samples from site CNR-19, located downstream of the Chase's Pond Dam, had low bacteria concentrations during all sampling events. Samples from site CNR-05, located on the northern upstream tributary, had elevated concentrations of bacteria during the wet sampling event in May and also in the September event, which was preceded by rain. Concentrations at CNR-05 were low in dry events during June and July. These data suggest the runoff from land uses in this upper portion of this tributary does elevate bacteria concentrations. In the September sampling, the bacteria concentrations observed at CNR-05 did not persist downstream to CNR-02.

- Figure 7-2 shows that during the July sampling, tributaries with small flows such as CNR-11 and CNR-10, do not raise the bacteria concentrations in the main stem of the river, despite the presence of elevated bacteria in the tributaries. CNR-13, with higher flows, appear to have a measureable impact on the main stem, though the main stem concentrations remain below the criteria.

- Data from June and September also suggest that the impact from the tributaries on the main stem bacteria concentrations is limited and the main stem remains below the bacteria criteria.

- Figure 7-3 shows that during the May (wet) sampling event, there is an increasing trend of bacteria concentrations in the main stem and suggests that the input from the tributaries contributes to this trend.

- Figure 7-3 also shows a marked increase in the trend of bacteria concentrations downstream of the Shore Road Bridge, suggesting that CNR-09 could be a significant contributor to bacteria load in the river after rain events.

Figure 7-2
July 2012 Bacteria Concentrations
Lower Cape Neddick River

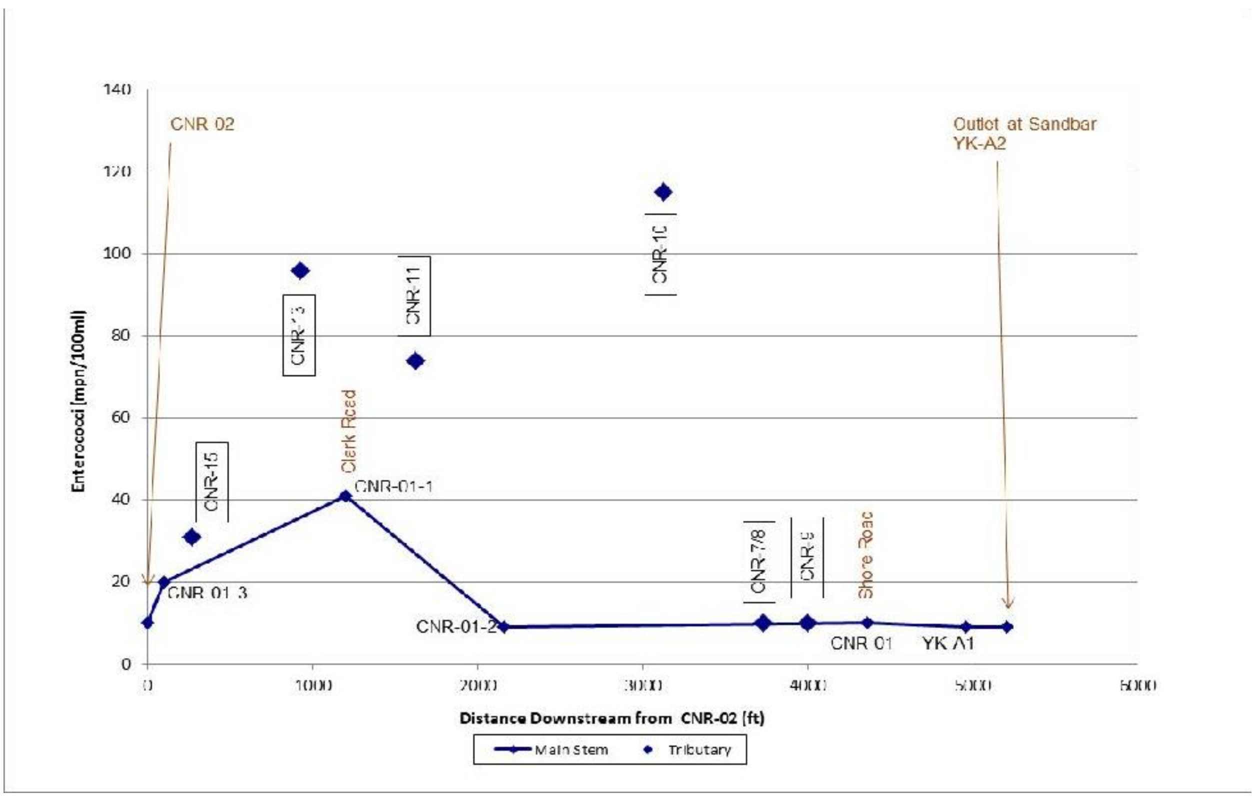
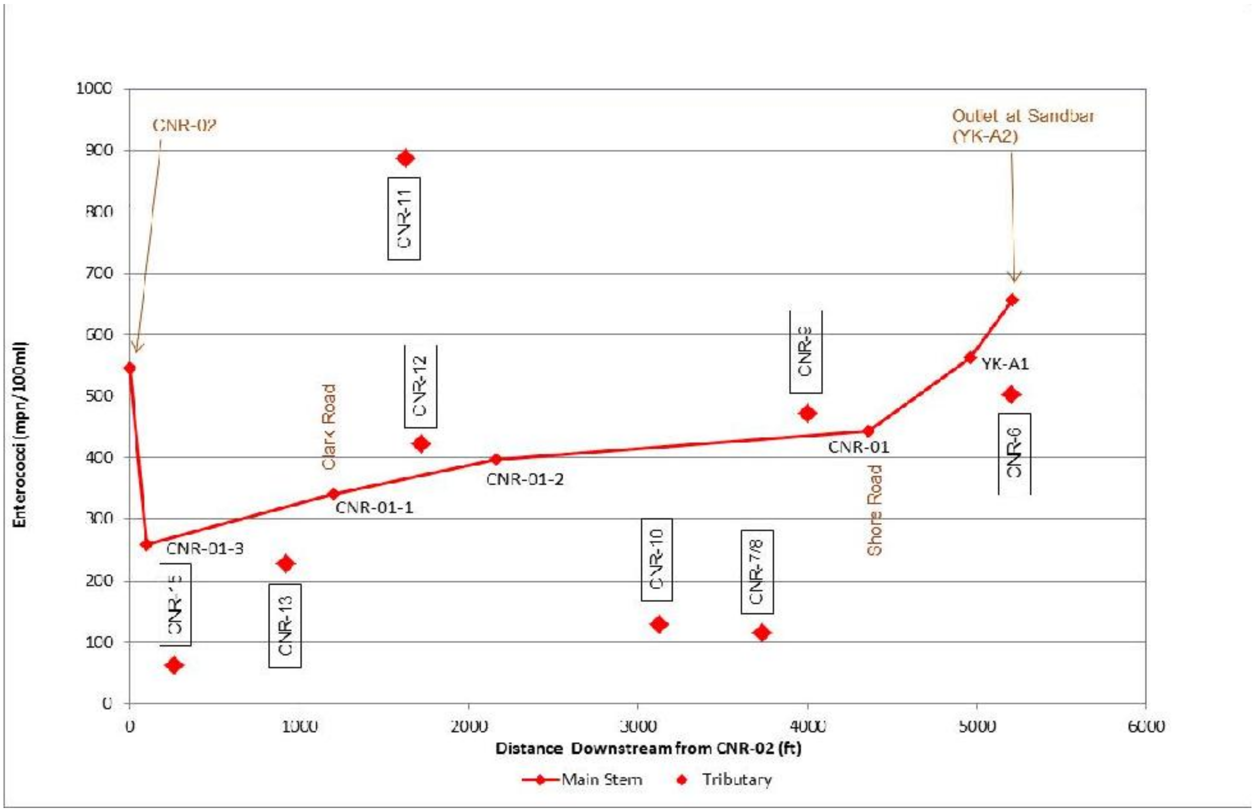


Figure 7-3
May 2012 Bacteria Concentrations
Lower Cape Neddick River



7.5 Summary of 2012 Bacteria Data

The 2012 bacteria sampling was intended to augment the historical database and provide additional information to clarify the impacts of the tributaries on the CNR Estuary, which has been designated as impaired by the MEDEP.

The 2012 data clearly show that the primary condition when bacteria concentrations are elevated above the criteria in the main stem of the river is during the approximately 24-hour period immediately following a rain event. The 2012 sampling data, along with historical data and an assessment of potential flow volume from each subwatershed, have also been used to identify priority subwatersheds where mitigation measures can be focused to improve water quality both in the tributaries and the main stem of the river.

8. IDENTIFICATION AND DESCRIPTION OF PRIORITY SUBWATERSHEDS

This section identifies priority subwatersheds based on the evaluation of the water quality databases described in Sections 5 and 7 as well as an assessment of the potential flow volume from each subwatershed. Another factor in determining which subwatersheds receive priority is the listing of the CNR Estuary as an impaired water body by MEDEP. Accordingly, and as described in more detail in Section 3, a TMDL is required for the estuary and associated restoration efforts should initially be concentrated in this area.

Six priority subwatersheds have been selected. They are identified by their associated sampling location identifier. The priority subwatersheds and their respective annual flux (flow) ranges and *Enterococci* maximum and geomean concentrations from 2012 are listed in Table 8-1. Brief comments supporting selection of these particular subwatersheds are also included in Table 8-1.

Table 8-1
Priority Subwatersheds
Cape Neddick River

	Estimated Flux Range (gpm)		Enterococci (MPN/100ml)		
Subwatershed	**Low**	**High**	**Max**	**Geomean**	**Comments**
CNR-06	4	194	24,196	1,706	Flows across Cape Neddick Beach, high bacteria concentrations during wet and dry conditions.
CNR-09	8	378	473	19	Relatively large populated subwatershed, high bacteria concentrations during runoff with relatively high maximum flux.
CNR-10	5	248	130	82	Elevated bacteria concentration during wet and dry conditions.
CNR-11	2	122	888	151	Small subwatershed but consistently high concentrations during wet and dry conditions.
CNR-13	24	1,042	228	87	Large subwatershed with high flux, fairly high concentrations during wet and dry conditions
CNR-15	3	143	410	80	Smaller flow but historically contains high concentrations, especially during wet conditions.

Figures 8-1 and 8-2 show the priority subwatersheds located on the north and south sides, respectively, of the lower CNR. Table 8-2 lists pertinent statistics for each of the priority subwatersheds. This information was gleaned from parcel maps and databases provided by the Town.

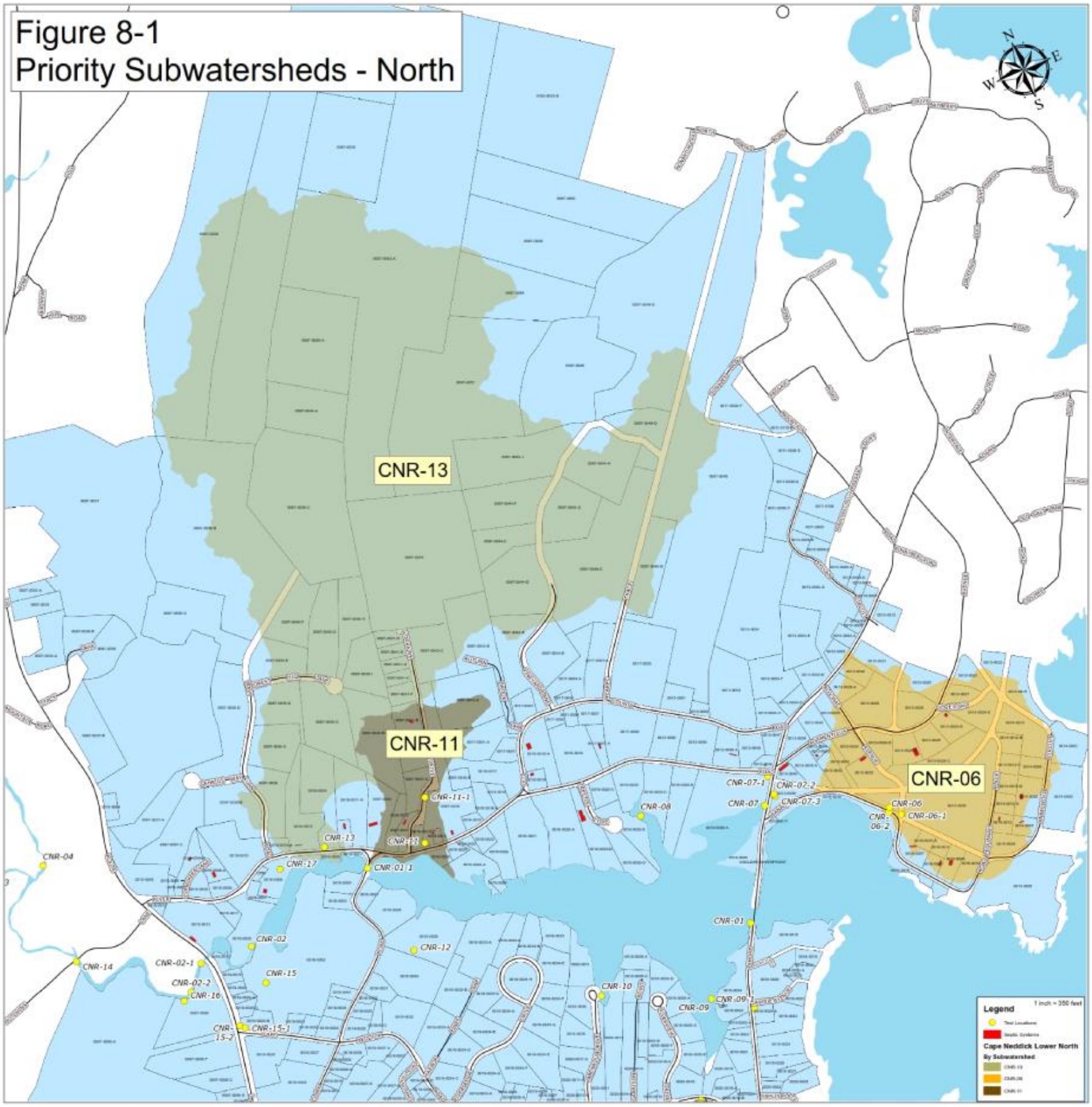
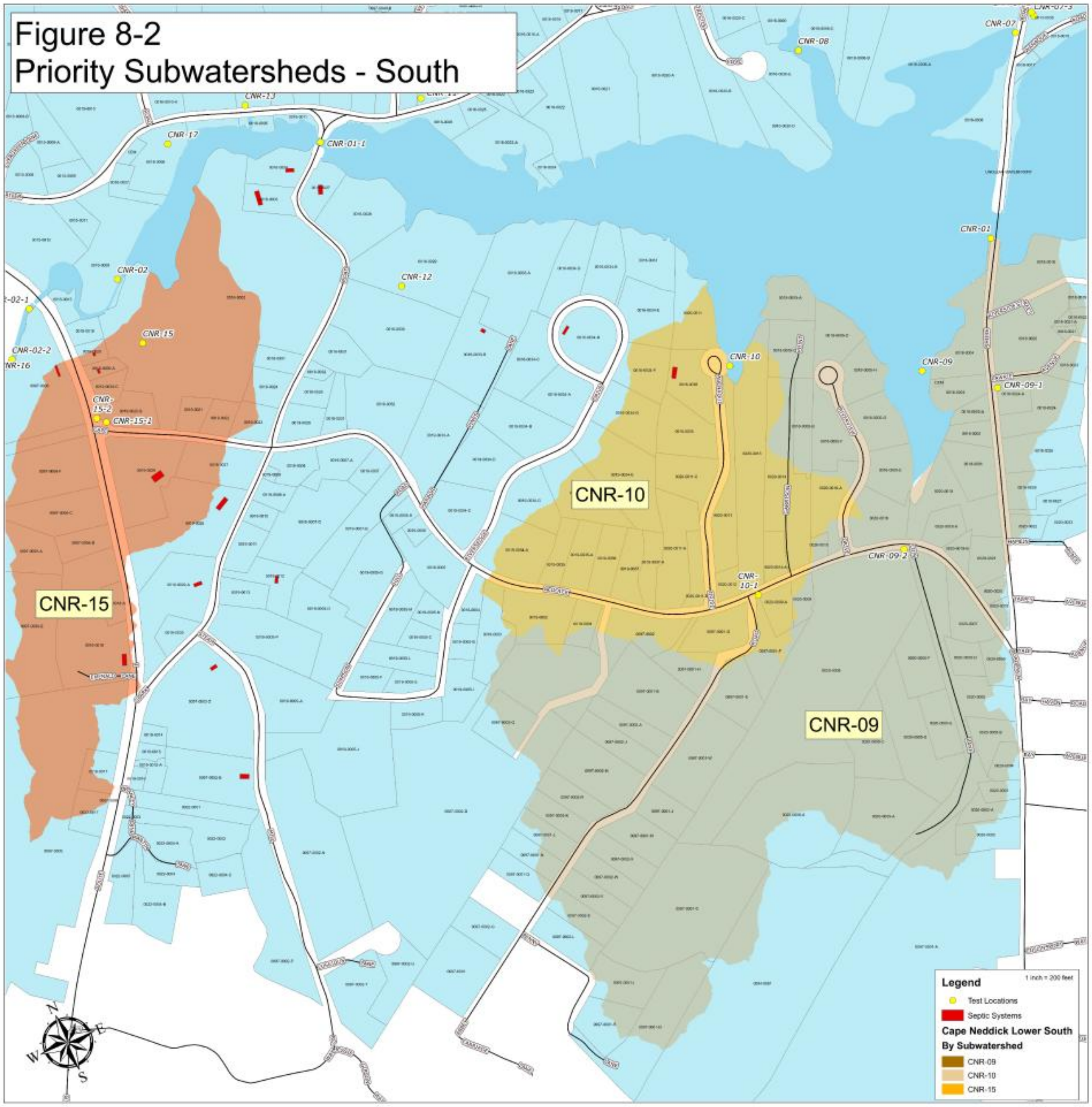


Figure 8-1
Priority Subwatersheds - North

Note: Septic systems are shown only where Town has information on their location.



Note: Septic systems are shown only where Town has information on their location.

Table 8-2
Priority Subwatershed Statistics
Cape Neddick River

Statistic	CNR-06	CNR-09	CNR-10	CNR-11	CNR-13	CNR-15
Total Acres	46	90	33	17	249	34
Number of Houses	30	56	27	7	20	17
Average House Age	1976	1960	1964	1945	1986	1944
Acres of Built House Lots	31.17	66.26	32.58	8.23	80.86	22.23
Acres Per Built House Lot	1.04	1.18	1.21	1.18	4.04	1.31
Overall Density (Acres/ Houses)	1.53	1.61	1.22	2.43	12.45	2.00

Table 8-2 highlights several key statistics related to the priority subwatersheds which will be used in the following section for the TMDL study. Implications of some of the statistics include:

- Unless septic records indicate otherwise, septic system age is assumed to be the same as the house age. Older septic systems are more likely to be poorly designed and may have failed prematurely. Older septic systems that have been well-designed may have reached the end of their useful life even if they have been properly maintained.

- Acres per built house lot indicates the area available for septic system installation. Considering other constraints on a house lot such as wet areas, smaller lot size could limit space available for a properly functioning septic system.

- Overall density indicates the amount of natural area available to buffer stormwater runoff from developed areas. Accounting for the house, driveway, and lawn, developed areas consume space otherwise available for buffering.

9. TOTAL MAXIMUM DAILY LOAD (TMDL) STUDY

The MEDEP listing of the CNR Estuary as a water body impaired by bacteria (MEDEP 2009) requires that a TMDL be developed for the estuary and an associated study prepared and approved by the EPA. This section satisfies the first criterion from the list of nine EPA criteria (see Subsection 2.1) for a WBMP.

The TMDL requirement is not a product of the municipal separate storm sewer system (MS4) program that MEDEP has imposed on the Town of York, but it will likely become incorporated into that program. Under the MS4 program administered by the MEDEP, York must implement six "minimum control measures" for reducing the discharge of pollutants to surface water bodies from storm sewer systems and protecting water quality from NPS pollution. MEDEP has indicated that impaired (TMDL) water bodies within MS4 communities may receive special consideration for grant funds under the 319 program.

9.1 Purpose of Study

The TMDL study is intended to accomplish three major objectives:

1. Identify the bacteria sources within the study area.
2. Quantify the contribution from each bacteria source within the study area.
3. Determine the reduction from each <u>human and domestic animal</u> bacteria source required to meet the applicable TMDL for the CNR Estuary.

9.2 Cape Neddick River Estuary TMDL

A statewide TMDL has been established for water bodies impaired by bacteria in Maine. Water quality standards applicable to Maine waters are used as the numeric water quality targets for bacteria TMDLs. Since the CNR Estuary is Class SB, the associated *Enterococci* bacteria standard listed in Table 3-1 serves as the applicable bacteria TMDL for the CNR Estuary. Accordingly, between May 15th and September 30th, *Enterococci* of <u>human and domestic animal</u> origin shall not exceed a geometric mean of 8 MPN/100ml or an instantaneous level of 54 MPN/100ml.

9.3 Bacteria Reductions Necessary to Achieve TMDL

Water quality data has shown that *Enterococci* concentrations in the CNR Estuary vary widely depending on a number of factors including rainfall amounts, elapsed time since the cessation of rainfall, and tidal influences. Consequently, the *Enterococci* reductions necessary to achieve the TMDL will vary widely depending on these factors. Most of the regulated period between May 15th and September 30th is dry, so the TMDL should be achievable during most of this period. This conclusion is supported by 2012 data (Table 7-3 and Figure 7-1) that show the instantaneous *Enterococci* level was never exceeded in the estuary under dry conditions. It is under wet conditions that the TMDL will almost never be achieved unless mitigation measures are directed toward bacteria sources. The peak *Enterococci* concentration measured in the estuary during the "wet" May 2012 sampling event was 657/100ml at YK-A2. It would require a 92% reduction in *Enterococci* to achieve the instantaneous standard under these conditions. The

MHB database shows even higher *Enterococci* levels at Cape Neddick Beach on five occasions since 2003, indicating that even higher removals would be needed to achieve the standard under more severe conditions.

Bacteria found in estuary water likely come from a variety of sources, including wildlife. The 2003 UNH ribotyping analysis showed that, in addition to human and domestic animal sources, bacteria sources included many types of wildlife (Jones, 2003). Determining a set percentage of *Enterococci* from wildlife sources is impossible to calculate since it will vary over time and location within the estuary. Presumably, it is almost always present within estuary water, suggesting that removal rates dictated by the TMDL are not as high as those discussed above. However, for the purposes of this WBMP, it is assumed that bacteria mitigation measures will need to target all potential human and domestic animal sources in order to achieve the TMDL for the CNR Estuary under wet and dry conditions.

9.4 Pollutant Source Identification

In a non-sewered watershed such as the CNR Watershed, potential sources of bacteria include failing septic systems, illegal dumping into the storm drain system, domestic animals, and wildlife. The following sections discuss each of those sources.

Although the CNR Estuary falls within the safety zone around the YSD treatment plant outfall, and there is the potential that untreated or partially treated sewage could be discharged into Cape Neddick Harbor in the unlikely event of a disruption at the treatment plant, it is not considered to be one of the sources contributing to exceedances of the bacteria TMDL in the estuary.

9.4.1 Failing Septic Systems. Table 9-1 provides a comparison of *Enterococci* concentrations in discharge from different sources, including failing septic systems. Forest runoff is presumed to be influenced by only wildlife sources.

Table 9-1
***Enterococci* Concentrations in Discharge from Different Sources**

Discharge Source	*Enterococci* (MPN/100ml)
Raw Sewage	1,200,000
Failing Septic Systems	100,000
Urban Stormwater Runoff	10,000 – 100,000
Forest Runoff	100 – 1,000

References: Pitt, 1998; Lim and Oliveri, 1982; Smith et al., 1992; Horsely & Witten, Inc., 1995

As shown in Table 9-1, *Enterococci* concentrations in discharge from failing septic systems are reported to be two to three orders of magnitude higher than in forested runoff. It should be noted that discharge from failing septic systems is significantly diluted when it mixes with flowing water in streams and rivers. Therefore, samples collected from flowing water in CNR tributaries and the estuary would not be expected to reflect the concentration shown in Table 9-1, even if they were affected by discharge from a failing septic system.

About one-fourth of all American households rely on on-site septic systems to dispose of their wastewater. After solids are trapped in a septic tank, wastewater is distributed through a subsurface drain field and allowed to percolate through the soil. Bacteria are effectively removed by filtering and straining wastewater through the soil profile, if the septic system is properly located, installed, and maintained. However, when wastewater breaks out from the subsurface onto the ground surface or passes through the soil profile without adequate treatment, a septic system is said to have failed and is no longer providing sufficient treatment of bacteria. The regional rate of septic system failure across the country is reported to range from 5 to nearly 40 percent, with an average of about 10 percent (Glasoe and Tompkins, 1996; Hunter, 1998; Johnson, 1998; Smayda et al., 1996; Tuthill, 1998). The introduction of the Maine Septic Code in 1974 standardized septic system design and is credited with significantly reducing the rate of septic system failure in this state.

The causes of septic system failure are numerous: inadequate soils, poor design, hydraulic overloading, tree growth in the drain field, old age, and failure to clean out. The following factors can increase the risk of septic system failure:

- Systems that are older than 20 years;
- Systems situated on smaller lots;
- Systems that service second homes or provide seasonal treatment;
- Systems adjacent to shorelines or ditches; and
- Systems that are located on thin or excessively permeable soils, or are close to bedrock or the water table.

The design life of most septic systems is 15 to 30 years, at which point major rehabilitation or replacement may be needed. Town records indicate that more than half of the septic systems in the CNR priority subwatersheds are at least 30 years old. In addition, most soils in the area are poorly drained, potentially increasing the risk of break-outs occurring as septic systems age.

9.4.2 Illegal Dumping into Storm Drain System. Nationwide, there is quite a bit of anecdotal evidence of illegal transient dumping of raw sewage into storm drains from septage vac trucks (i.e., honey wagons), recreational vehicles, and portable toilets (Johnson, 1998). In addition, there may be inadvertent dumping from moving vehicles, such as livestock carriers and recreational vehicles. The overall significance of illegal or inadvertent dumping as a watershed bacteria source, however, is hard to quantify. Storm drains are present in the CNR watershed but, without a comprehensive investigation, there is no way of knowing if dumping is a problem locally.

9.4.3 Domestic Animals. Documented domestic animal sources of bacteria in the CNR Watershed include cats, dogs, and cows (Jones, 2003). Ribotyping analysis of *E.* coli in 2003 found evidence of cat strains in a sample collected at the Shore Road Bridge and evidence of cow and dog strains in a sample collected just downstream of Hutchins Lane Bridge.

Nationwide, cats and dogs appear to be a major source of bacteria and other microbes in urban watersheds. Dog feces were the single greatest source contributing fecal coliform and *Enterococci* in highly urban Baltimore catchments (Lim and Oliveri, 1982). Cats and dogs were

the primary source of fecal coliforms in urban subwatersheds in the Puget Sound region (Trial et al., 1993).

Horse pastures and hobby farms are typically found around the fringe of more developed areas. Although these operations are very small, the stocking density is often high, and grazing and riparian management practices are seldom applied. It is unknown how many of these may exist in the priority subwatersheds but they are certainly present within the CNR Watershed.

9.4.4 Wildlife. Documented wildlife sources of bacteria in the CNR Watershed include deer, otter, raccoon, red fox, geese, and seagulls (Jones, 2003). The ribotyping analysis suggested that wildlife and birds are the types of species that contribute most significantly to bacterial pollution in the watershed.

Nationwide, geese, gulls, and ducks are speculated to be a major bacterial source where large resident populations have become established. An increase in *E. coli* from flocks of seagulls roosting near reservoirs and geese and ducks utilizing stormwater impoundments have been detected (Levesque et al., 1993 and Moorhead et al., 1998). The Maine Department of Inland Fisheries and Wildlife study done in 1986 that gave the CNR the highest rating for riparian habitat and waterfowl wintering area is a qualitative indicator that waterfowl could be a major bacteria source.

Table 9-2 provides an interesting comparison of *Enterococci* densities in feces and the unit discharge of feces from a variety of species including ducks. It shows that the *Enterococci* density in duck feces is twice that in cat feces and at the same production rate (i.e., 0.15 lbs/day). Because of their larger size, geese would naturally be expected to have a higher production rate than ducks. It should also be noted that *Enterococci* density in dog feces is one to two orders of magnitude greater than the other species listed in Table 9-2, with a production rate approximately the same as that of humans.

Table 9-2
***Enterococci* Densities and Unit Discharge of Feces**

Source	*Enterococci* (MPN/gm)	Unit Discharge (lbs/day)
Human	3.0×10^6	0.35
Cats	2.7×10^7	0.15
Dogs	9.8×10^8	0.32
Cows	1.3×10^7	15.4
Ducks	5.4×10^7	0.15

References: Pitt, 1998; Godfrey, 1992; Geldrich et al., 1962

9.5 Priority Subwatershed Bacteria Load Calculations

Bacteria load calculations were performed to estimate the bacteria loads discharging to the CNR Estuary from each of the priority subwatersheds, as well as the contribution of each bacteria source within the subwatersheds. The calculations were made on a subwatershed basis so that, combined with previous evaluations of water quality data, restoration work in the lower CNR could be further prioritized.

9.5.1 Bacteria Source Load Calculator (BSLC) Spreadsheet Model. The BSLC model was used to estimate loads from the above identified bacteria sources including failing septic systems, domestic animals, and wildlife (Center for TMDL and Watershed Studies, Version 3.0). Bacteria loads from illegal dumping into the storm drain system were not estimated since they can't be quantified. Because of the inaccuracies inherent in modeling watersheds, bacteria loads calculated by the BSLC model are only rough estimates. But by using the same methodology for modeling all the priority subwatersheds, the <u>relative</u> impact that each subwatershed and its associated bacteria sources have on the CNR Estuary can be evaluated. Countless hours could be spent in improving the accuracy of the BSLC model by characterizing the subwatersheds in greater detail, but the limited improvement in accuracy would not be enough to justify the cost of doing so.

The BSLC is a software tool designed to simplify the complex and time-consuming work involved in estimating bacterial loadings. It was developed by the Center for TMDL and Watershed Studies at Virginia Tech in Blacksburg, VA. The BSLC has been used extensively in the development of bacterial TMDLs in VA and has the flexibility to be used for TMDL studies in other regions. In the absence of a watershed model tailored to Maine watersheds, the BSLC was selected as the best alternative for modeling the relative impact of priority subwatersheds on the CNR Estuary.

The BSLC takes user-generated, watershed-specific inputs including land use, population, septic, and wildlife estimates and calculates monthly bacterial loadings. Results can be displayed by source in colony forming units (cfu's) per month and year.

9.5.2 Modeling Assumptions and Model Inputs. To simplify the modeling process, several assumptions were made including:

- All properties are residential. Even though a few commercial properties exist within some of the priority subwatersheds, the scale of those properties is not considered sufficient to create a separate commercial category for modeling purposes.

- Year round occupancy is 1.6 residents per housing unit. This value was obtained from the 2000 U.S. Census (Appendix A in the Town of York Comprehensive Plan Inventory and Analysis Chapter on Population). Some of the subwatersheds have many homes that are seasonal, and the summer population is significantly greater than the year round population, but the season is relatively short and there are no figures available to quantify the population increase within each subwatershed over the summer months.

- Septic system failure rate is based on age of homes unless Town records indicate otherwise. The BSLC model uses the following default percentages for septic system failure rate:
  - Pre-1966 = 40%
  - 1966-1985 = 20%
  - Post-1985 = 3%

  These percentages closely match the national failure rates referenced in Subsection 9.3.1. The Town is in the process of updating its septic database. In those cases where there is a date of septic installation that is more recent than the age of home construction, the septic installation date is used in the BSLC model.

- Wildlife consists of deer, raccoon, and wild turkeys. In the absence of a method for estimating waterfowl populations within the subwatersheds, they were not included in the calculations. Additionally, it is expected that waterfowl reside primarily in the estuary proper rather than within the subwatersheds. Deer, raccoon, and wild turkeys are assumed to reside in the forested areas outside of developed parcels.

Table 9-3 includes inputs used for modeling septic system loading from each priority subwatershed. The total number of houses is also used to compute a pet population for each subwatershed.

Table 9-3
BSLC Model Inputs for Septic Systems
Cape Neddick River Priority Subwatersheds

Subwatershed	Number of Houses	Residents/ House	Septic Pre-1966	Septic 1966-1985	Septic Post-1985
CNR-06	30	1.6	8	6	16
CNR-09	56	1.6	19	17	20
CNR-10	27	1.6	10	3	14
CNR-11	7	1.6	2	3	2
CNR-13	20	1.6	1	3	16
CNR-15	17	1.6	10	3	4

Table 9-4 includes inputs used for modeling wildlife loading from forested areas within each priority subwatershed.

Table 9-4
BSLC Model Inputs for Wildlife
Cape Neddick River Priority Subwatersheds

Subwatershed	Deer Population[1]	Raccoon Population[2]	Wild Turkey Population[3]
CNR-06	7	2	2
CNR-09	11	4	3
CNR-10	1	0	0
CNR-11	4	1	1
CNR-13	81	27	17
CNR-15	6	2	1

References: [1] Maptech, 2000; [2] VA Department of Game and Inland Fisheries; [3] Brannan et al., 2002

9.5.3 Model Outputs and Observations. Figure 9-1 illustrates the BSLC output for each subwatershed based on the above assumptions and model inputs. Figure 9-2 illustrates the percent contribution of bacteria loading from humans, pets, and wildlife from all the priority subwatersheds combined.

Figure 9-1
Estimated Fecal Coliform Loadings
Cape Neddick River Priority Subwatersheds

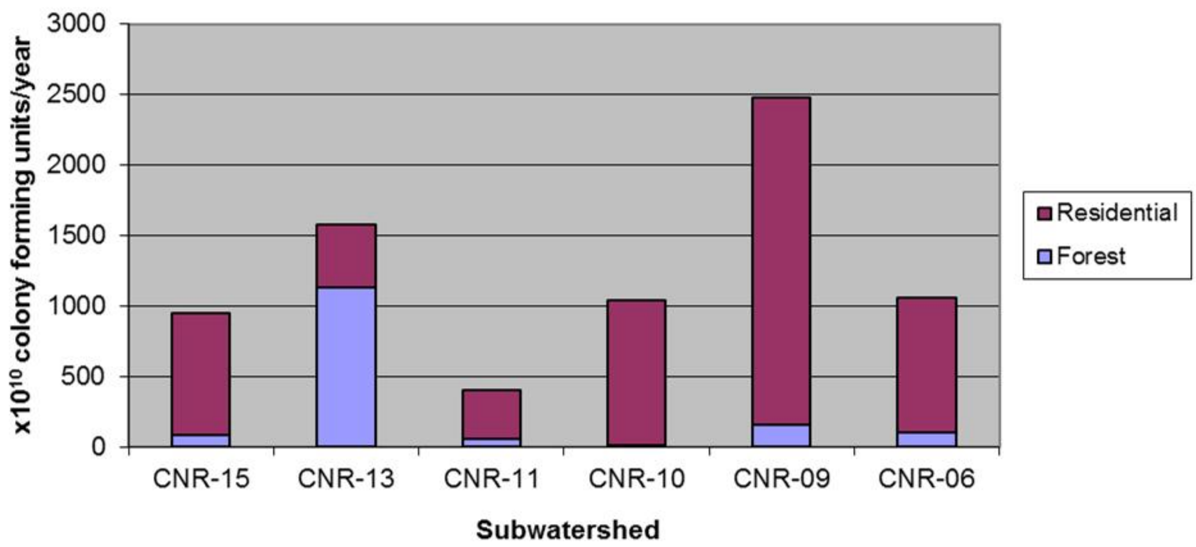
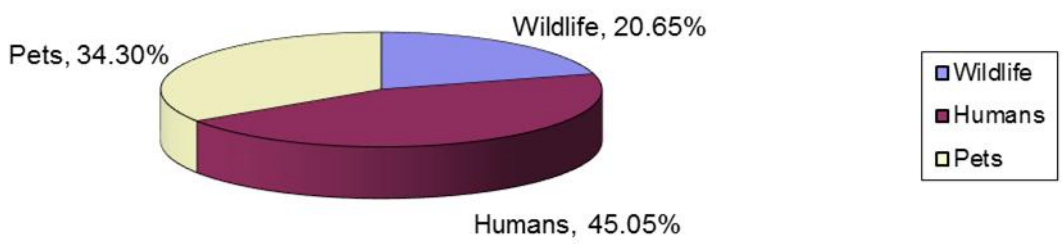


Figure 9-2
Estimated Percent Fecal Coliform Loading
from Priority Subwatershed Sources



Inspection of Figures 9-1 and 9-2 produced the following observations:

- CNR-09 potentially generates the overall largest bacteria load and the largest bacteria load from residential sources (i.e., failing septic systems and pet waste).
- CNR-13 potentially generates the second largest bacteria load but the majority of it is from forest sources (i.e., wildlife).
- CNR-06, CNR-10, and CNR-15 potentially generate similar bacteria loads, the majority of which are from residential sources.
- CNR-11 potentially generates the overall smallest bacteria load.
- Humans (i.e., failing septic systems) are potentially the largest source of bacteria loading to the estuary.
- Pets are potentially a significant contributor to overall bacteria loading to the estuary.

9.5.4 Model Output Versus 1974 Maine Septic Code. In order to check model output against conditions reflective of septic system development in Maine, Figure 9-3 was prepared to show the number of systems in the priority subwatersheds installed before 1974 versus 1974 and later. As mentioned in Section 9.3.1, the introduction of the Maine Septic Code in 1974 standardized septic system design and is credited with significantly reducing the rate of septic system failure in this state.

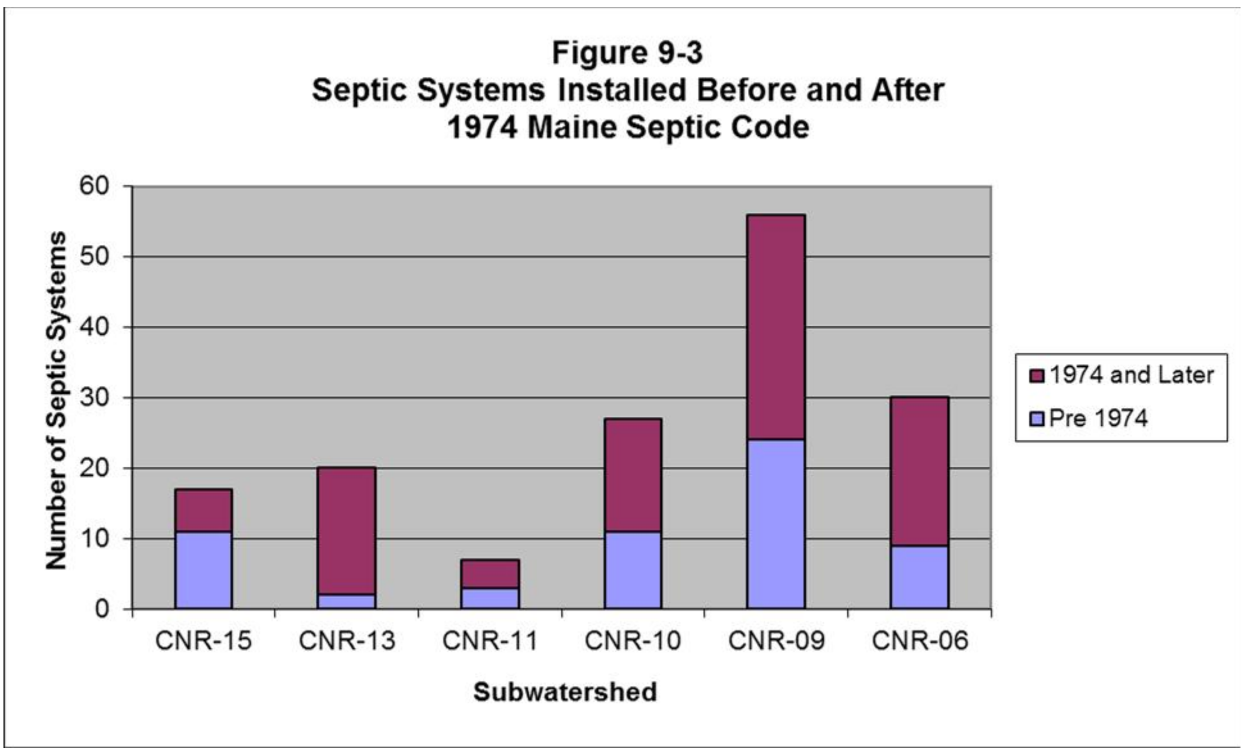


Figure 9-3 shows that CNR-09 contains the highest number of pre-1974 septic systems, suggesting that it may be the priority subwatershed with the highest number of failing septic systems. CNR-10 and CNR-15 have the second highest number of pre-1974 septic systems. CNR-13 has the fewest number of pre-1974 septic systems. These observations are not inconsistent with the estimated fecal coliform loadings shown in Figure 9-1.

9.6 TMDL Study Conclusions

The following conclusions were drawn from the above TMDL study:

- The TMDL should be achievable during most of the regulated period between May 15th and September 30th when conditions are normally dry.
- Failing septic systems and pet waste appear to be the primary bacteria source in all the priority subwatersheds except CNR-13.
- Wildlife appears to be the primary bacteria source in CNR-13, with waterfowl likely a major direct contributor of bacteria to the estuary.
- The largest sources of human and pet bacteria appear to be associated with the three downstream priority subwatersheds (i.e., CNR-10, CNR-09, CNR-06), which is consistent with the trend of increasing *Enterococci* concentrations as shown in Figure 7-2 (wet conditions).
- Bacteria mitigation measures will need to target all potential human and domestic animal sources in order to achieve the TMDL for the CNR Estuary under wet conditions.

10. POTENTIAL BACTERIA MITIGATION MEASURES

This section describes six potential mitigation measures for meeting the bacteria TMDL in the CNR Estuary as well as other water quality standards in freshwater portions of the CNR, the Estuary, and at the Cape Neddick Beach. This section also satisfies the third criterion from the list of nine EPA criteria (see Subsection 2.1) for a WBMP.

10.1 Identification and Replacement of Failing Septic Systems (MM-1)

As described in Section 9.3.1, subsurface wastewater disposal systems (commonly referred to as septic systems) have the potential to contribute bacteria to the CNR tributaries and main stem as they age or if they are improperly designed, constructed, and/or maintained.

Bacteria in domestic wastewater moves along with the wastewater plume through the soil, and research has shown that bacteria can remain viable in the ground for up to 100 days. The rate of groundwater flow in the CNR watershed is likely to be less than 1 foot per day.

Based on this, there are several conditions that could occur to allow a septic system to impact CNR bacteria levels (i.e. fail):

1. Septic systems with leach fields closer than 100 feet from a CNR tributary might allow bacteria to reach the tributary while they are still viable;

2. Septic systems that include improperly located curtain drain features that capture wastewater and pipe it to the ground surface; and

3. Septic systems where wastewater emerges from the ground near the edge of the leachfield or at other nearby low points and the untreated wastewater washes into the CNR drainage system during periods of runoff.

As noted in Section 7, the 2012 data show that storm events increase bacteria concentrations in the CNR and its tributaries. Conditions 2 and 3 allow bacteria to be washed into the tributaries as runoff during a storm event. Consequently, they could be the direct and/or indirect source of the bacteria contamination.

A two-step process to identify and mitigate potentially failing septic systems is described below.

Identification of Failing Septic Systems. On-site inspection by an experienced site evaluator or other professional with experience designing and installing septic systems is an effective way to identify potentially failing systems. The inspection would involve:

- Compiling available HHE-200 and associated records from Town and State files for the target lots;
- Compiling published information on soil type for the target lots;

- Preparing a mailer explaining the purpose and nature of the inspection and asking for voluntary permission from the landowner to access the property for a limited, non-invasive preliminary evaluation;
- Inspecting lots where permission is obtained to verify site features, examine soil conditions in the existing leachfield (this can be done using hand tools), identify potential areas of wastewater seepage or breakout, inspect for drainage pipe outfalls and evaluate site soils for potential leachfield replacement; and
- Preparing an area map with the graphic representation of the results of the survey in order to evaluate the potential for 'hot spots' or areas of concern based on septic system conditions, locations, age, underlying soils, etc.

Information gathered during the on-site inspections will allow the inspector to determine if one of the potential failure conditions described above exists on each lot.

Replacement of Failed Septic Systems. The information gathered from the on-site inspection can be used to evaluate the replacement options for failed systems. The site visit would gather information to determine whether a replacement system (a) could meet existing code, (b) would need limited variances or (c) would need extensive engineering and/or state variances. Based on the ability to meet code requirements, or variances needed, a generalized cost could be estimated for replacement of failed systems.

Before considering replacement of individual systems, the Town may want to compare the overall number of replacement systems needed and the approximate total cost to the cost of extending the sewer system to part or all of the lower CNR watershed. While it is not the only consideration, comparative cost would be one component of a decision to extend the sewer system rather than replace existing systems.

The State of Maine Subsurface Wastewater Disposal Rules classify existing dwellings as grandfathered. Therefore, if it is determined that individual septic systems have failed and are impacting the river, a replacement system would be allowed. The property owner would be requested to present a replacement system designed by a Licensed Site Evaluator that made the best effort to comply with the existing standards within the site/soil constraints. Variances to setbacks and other standards are routinely granted by Towns and the State if the proposed replacement system is the best upgrade available based on site soils and state of the art technologies available at the time.

Currently all aspects of operation, maintenance, replacement, etc. of septic systems located on private property are the responsibility of the property owner. Therefore, the cost for a replacement system would be assumed by the land owner. However, since improvement of water quality in the CNR is also a community goal, the Town may want to explore alternative approaches to assist a private landowner and provide incentive to allow on-site inspection and replacement of failing systems. These approaches might include design support, coordinated contracting to lower installation costs, grants, low-interest loans, property tax adjustments or other measures.

10.2 Proper Maintenance of Septic Systems (MM-2)

The Town of York currently requires that property owners in the lower CNR watershed pump their septic tanks at least every five years. It appears that most local septic haulers who serve the area routinely provide information to the Town to identify which lots are pumped. In addition to regular pumping of septic tanks (recommended every 3 to 5 years at a minimum depending on site use and occupancy), it is prudent to inspect the outlet baffle of the septic tank to assure that it is intact, in good condition, and preventing the greases and the sludge from exiting the tank and prematurely plugging the leachfield area with unwanted solids accumulation. Concrete baffles corrode over time due to the hydrogen sulfide and methane in the wastewater and have a tendency to deteriorate and fall off. Plastic tees are resistant to corrosion from wastewater but can become dislodged and fall off as well.

In today's technology, advanced wastewater treatment (AWT) systems (e.g., aerobic treatment tanks) are becoming more common. These units improve the quality of the wastewater prior to discharging into the surrounding soil but rely on electrical power and mechanical components. With AWT systems, an annual service and inspection is recommended to assure that the unit is performing up to the design and permit standards.

10.3 Management of Pet Waste (MM-3)

Pet waste was identified as a significant source of bacteria in Section 9. Increased public awareness of the threat that pet waste poses to CNR water quality would be a major part of a campaign to manage pet waste.

Strategically placed signs in public areas frequented by dog owners that inform them of the potential of dog waste for degrading water quality, and the things that they must do to comply with local ordinances concerning control of dog waste, are an effective tool. Mass mailings of brochures enclosed with official town notifications (e.g., septic pumping requirements) related to protecting water quality could also be used to educate the public. Digital copies of the brochures could be emailed to watershed residents. An example of a brochure used by another community for these purposes is provided in Appendix D.

The Town of York already has an ordinance that, among other provisions, directly and indirectly regulates the management of animal waste. The Town of York Animal Control Ordinance, most recently amended on November 2, 2010, includes several provisions that relate to mitigation of primarily dog waste. Those provisions include:

- With a few exceptions (including public beaches within certain windows of time), voice control is not an acceptable means of controlling a dog. When off the premises of the owner, a dog shall be on a leash and under control of a person responsible for the dog's behavior.

- Other than on the property of the dog's owner or on the property of a person who has consented to the dog's presence, the dog's owner must remove and dispose of any waste left by the dog on any sidewalk, street, beach, public property or private property and

deposit the waste into an appropriate litter receptacle. Where this provision applies, the dog's owner must have a plastic bag or similar container for collecting and removing dog waste.

- On public beaches (including Cape Neddick Beach), no dogs are allowed between the hours of 8:00 AM and 6:00 PM from May 20th through September 20th. At other times of the day or year, dogs are allowed but must be either under voice control or on a leash depending on the time of day or year.

The above provisions, if enforced, will effectively limit some of the dog waste that could be washed into nearby drainage ways and water bodies. Owners of dogs on a leash are more likely to be cognizant of a dog's activities (including defecating) than if they are under voice control.

Ideally, dog owners will realize through educational initiatives that it is in their best interest and the interest of the community to pick up after their pets on their own property. Presumably, most pet waste is deposited on private property, and a voluntary effort to pick up and properly dispose of that waste is needed to make significant reductions in the overall bacteria loading from pet waste. The Cape Neddick River Association (CNRA) has spearheaded a similar educational initiative with the Lawns to Lobsters program.

10.4 Re-Establishment of Vegetated Stream Buffers (MM-4).

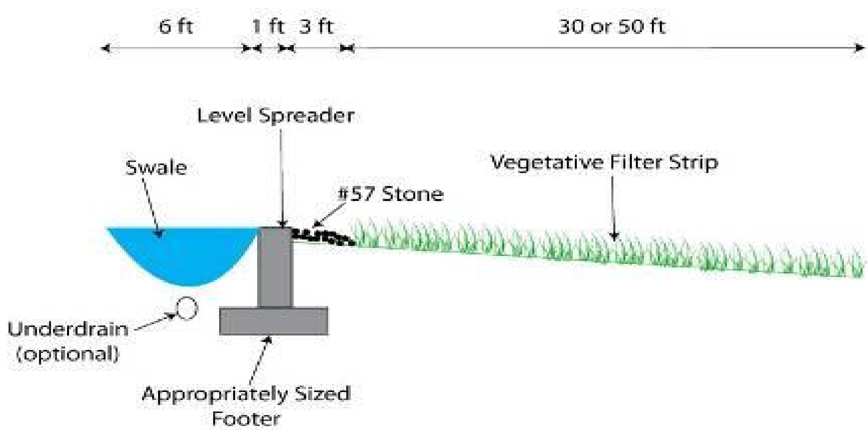
Vegetated stream buffers are widely recognized for their potential to filter sediment and other pollutants (including nutrients) from stormwater runoff. They also have other benefits such as flood control, stream bank stabilization, stream temperature control via shading, and enhancing habitat diversity. Another benefit to property owners that is often unrealized is that they can be a deterrent to geese. Given the choice of a wooded buffer or a manicured lawn as a place to feed and rest, geese typically prefer the lawn which can become a repository for their waste. The ability of vegetated stream buffers to remove bacteria from runoff is more uncertain. Some indication of their potential effectiveness, however, can be inferred from the performance of grass filter strips used to treat runoff from crops and livestock operations. For example, Coyne et al. (1995) found that grass filter strips were able to remove 43 to 70 percent of fecal coliforms in two experimental grass filter plot studies, while Young et al. (1980) reported 70 percent coliform removal from a 100-foot grass filter strip. However, other researchers found that grass strips with shorter flow lengths or high bacteria influent concentrations had limited effectiveness.

One of the most widely recognized buffer planning models is the three-zone buffer that was developed by the U.S. Department of Agriculture Forest Service (Welsh, 1991). Zone 1 of the model begins at the edge of the active channel and extends a minimum of 15 feet along a line perpendicular to the water course. Dominant vegetation consists of existing or planted woody vegetation suitable for the site conditions (e.g., sunny versus shady, well-drained versus poorly-drained soils). This zone should remain undisturbed, therefore, tree removal is generally not permitted. Zone 2 begins at the edge of Zone 1 and extends a minimum of 60 feet perpendicular to the watercourse. While vegetation in Zone 2 should be similar to Zone 1, removal of tree and shrub products is permitted on a regular basis provided the trees and shrubs are replaced. Zone 3 begins at the outer edge of Zone 2 and has a minimum width of 20 feet. Vegetation in this zone

can be field grass or lawn grass (less mowed the better) as long as it converts concentrated overland flow to uniform, shallow, sheet flow through the use of structural practices such as level spreaders.

Conversion of concentrated flow to sheet flow at the upland edge of vegetated stream buffers is a very important element in buffer design. The velocity of the water is slowed as it enters the buffer, allowing sediment with attached pollutants to settle or be trapped by the vegetation and to promote infiltration of water with dissolved pollutants into the soil. The level spreader should be carefully designed and constructed so that the vegetated buffer is not short-circuited by concentrated flow. Figure 10-1 illustrates the concept of the level spreader. Concentrated flow enters a ditch that could be grass-lined or lined with stone to reduce erosion where applicable. The water then spills evenly over a spreader lip installed along a level grade. The spreader can be constructed from a variety of materials but stone is commonly used in Maine to evenly distribute the water into the buffer.

Figure 10-1
Level Spreader Profile



The York Code Enforcement Officer should be contacted anytime disturbance of soils and/or existing vegetation is proposed adjacent to a water body. Requirements under the Shoreland Zoning Ordinance and the Natural Resources Protection Act will apply. Permits may be required depending on the type of work involved.

10.5 Low Impact Development Retrofits (MM-5)

Low impact development (LID) is a term used to describe a method of stormwater management that attempts to replicate the natural hydrology of a site. Before development of a site, there is typically a pit and mound topography of the forest floor that serves to create small ponded areas where stormwater runoff has an opportunity to infiltrate into underlying soils. Pollutants are

either filtered from the water or are adsorbed to soil particles as the water passes through the soil column. Also, groundwater is naturally replenished through this process.

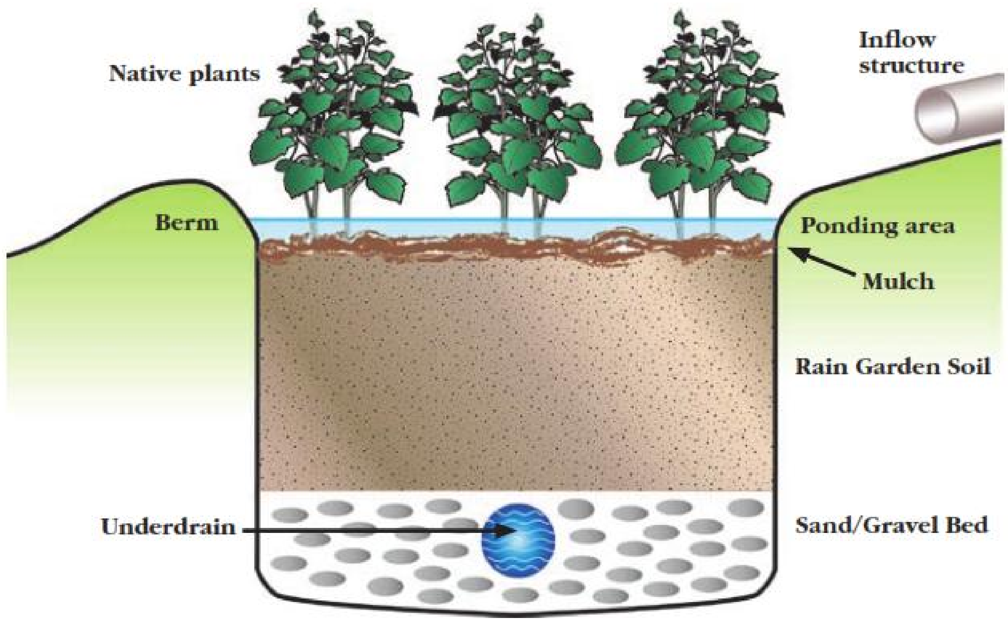
As a site becomes developed, the ground is leveled and impervious surfaces such as roads, roofs, and driveways are added. Stormwater runoff in the developed environment no longer has the same opportunities to infiltrate into soils as it does in the natural environment, so the water concentrates and flows overland or through ditches and pipes until it reaches a place (manmade or natural) where it discharges with its full complement of pollutants. Manmade structures such as stormwater ponds are designed to control flooding and remove pollutants, however, if no stormwater structures are built to intercept the flow, water bodies that ultimately receive the stormwater can be impacted by both flooding and pollutants. Research points to the strong influence of impervious cover on coastal/estuarine systems such as shellfish beds and wetlands (Duda and Cromartie, 1982; Hicks, 1995; and Taylor, 1993). Interestingly, each study found degradation thresholds when impervious cover exceeded 10 percent.

LID retrofits seek to return the hydrology of a developed site into a more natural state by constructing features disbursed throughout a site that serve to reduce imperviousness and/or infiltrate stormwater runoff. In this way, the stormwater is infiltrated throughout a site as opposed to the conventional method of directing it into a large collection system and treating it in a single large structure.

The LID retrofits come in a variety of forms including bioretention facilities, rain gardens, vegetated rooftops, dry wells, rain barrels (located under downspouts), and permeable pavements. Examples of a bioretention swale and a rain garden are shown in Figure 10-2. A cross-section of rain garden construction is shown in Figure 10-3.

Figure 10-2
Bioretention Swale and Rain Garden LID Practices

Figure 10-3
Rain Garden Cross-Section



Rain gardens can be do-it-yourself projects using guides available online, while the other LID practices (except rain barrels) require some engineering. On sites where native soils are less permeable, LID practices such as rain gardens and bioretention facilities may require underdrains to empty the feature of water before the onset of the next storm. In these situations, the feature becomes more of a filtering technology than an infiltration technology. Underdrained practices should be designed to treat the "water quality volume (WQV)". The WQV is the initial volume of runoff that is considered to carry the bulk of pollutants since the last runoff event. The MEDEP stormwater manual should be consulted for calculating WQV in addition to other design criteria.

10.6 Sewer Extension to Lower CNR Neighborhoods (MM-6)

Currently, the CNR Watershed is entirely without sewer. The capacity of the YSD treatment plant and its proximity to the neighborhoods on the south side of the lower CNR make it a potentially feasible alternative to septic systems for sewage disposal. The feasibility of sewering the south side neighborhoods was previously evaluated in a Sewerage Feasibility Study prepared for the YSD in 1994 (Anderson-Livingston Engineers, Inc., 1994). The study evaluated two alternatives for extending sewer into an area encompassing Main Street, Shore Road, and Route 1A and associated side roads up to Clark Road. The rationale for conducting the study was that small house lots were created in many areas which have marginal soils to support septic systems. Additionally, there were existing problems with the septic system that served the Cape Neddick Lobster Pound and the lack of a system at the Cape Neddick Campground. The feasibility study recommended an alternative that included one main pump station and several smaller package pump stations. Wastewater flows were estimated based on providing sewer service to all

existing structures and then available house lots. The total estimated flow for the study area was 74,300 GPD average flow, well within the excess capacity currently experienced at the YSD treatment plant.

More recently, engineering plans were prepared in 2006 for a sewer extension on Main Street and Shore Road up to Riverside Street at the Cape Neddick Campground. The project was put out to bid in 2007. The low bid was $1,617,729 (including alternatives) which translated to an average cost per household of $24,000, not including connection costs and an Impact Fee of $2,500. The YSD reviewed the plans and determined that plan modifications could reduce the average cost per household to $18,000, not including Impact Fee, connection costs, and the cost of pumps for residences not connected to a gravity line. The YSD was able to secure a low interest loan for the project from the State Revolving Loan Fund (SRF). At a public hearing on the project, the majority of affected homeowners were decidedly against the project and the project was shelved.

11. BACTERIA MITIGATION MEASURE EVALUATION

This evaluation of bacteria mitigation measures considers their effectiveness (i.e., estimated bacteria load reduction), implementability (including public acceptance and constructability), and cost. This section also satisfies the second and fourth criteria from the list of nine EPA criteria (see Subsection 2.1) for a WBMP.

Although MM-1 and MM-2 have been presented as separate mitigation measures, they are combined for purposes of their evaluation. Practically speaking, it is in the interest of the homeowner to preserve his or her investment in a new septic system by pumping the septic tank at the prescribed interval of every three to five years. Also, there is little point to pumping a septic tank at the prescribed interval if the septic system has already failed. A septic tank on a failed system is little more than a holding tank, and pumping it out at a much shorter interval (e.g., weekly) would be necessary to keep untreated sewage out of the environment.

11.1 Bacteria Removal Effectiveness

An accurate estimate of load reduction by each of the proposed mitigation measures is difficult to quantify. Consequently, relevant literature and the BSLC model are used to show the relative reduction in load that could be accomplished by controlling human and domestic animal sources (i.e., failing septic systems and pet waste). Based on the effectiveness evaluation, each mitigation measure is given a score of between “1” and “5” (“1” being least effective and “5” being most effective) assuming full participation from the watershed community.

MM-1 and MM-2. For purposes of modeling MM-1 and MM-2, it was assumed that replacement of most failed septic systems and regular pumping of septic tanks would yield the equivalent of all systems within each subwatershed representing “post-1985” systems with a failure rate of only 3%. A situation where there are no failures is unlikely because not all homeowners are expected to comply with the septic inspection program willingly and aging systems will continue to fail as they reach the end of their useful life.

Table 11-1 shows the reductions in bacteria loading from septic systems for each of the priority subwatersheds from “existing” bacteria loading as estimated in Section 9 to the “post-1985” loading scenario.

Table 11-1
MM-1 and MM-2 Septic Load Reductions ($x10^{10}$ cfu/year)

Subwatershed	Existing Load	MM-1/MM-2 Load	Percent Reduction
CNR-06	467	117	75
CNR-09	1402	234	83
CNR-10	584	117	80
CNR-11	234	0	100
CNR-13	117	117	0
CNR-15	584	117	80

It is apparent from Table 11-1 that there is considerable rounding of results with the BSLC model. Nevertheless, it does show that replacing failed systems with modern, well-designed systems has the potential to significantly reduce bacteria loadings compared to allowing the continued use of failed systems.
<u>Effectiveness Score = 4.</u>

MM-3. Estimating bacteria load reductions associated with the management of pet waste is very difficult because of the variability that comes with pet owner compliance with the Animal Control Ordinance and the level of public awareness potentially raised by information campaigns. No literature is available on the effectiveness of ordinances or education campaigns to curtail the pet waste problem.

The current scale of bacteria loading from pet waste has been estimated by the BSLC model in Section 9. Approximately 34% of the estimated bacteria loading from the priority subwatersheds may be due to pet waste (Figure 9-2). Accordingly, significant reductions (similar to estimated septic loading reductions) in pet waste would be required if there is a possibility of achieving water quality standards.
<u>Effectiveness Score = 4</u>

MM-4. Where MM-1, 2, and 3 are source control measures, MM-4 is a treatment measure. Vegetated stream buffers could be used to reduce residual bacteria loading after implementation of source control measures, but they should not be considered a standalone measure for achieving the loading reductions needed to achieve the water quality standards. Studies have shown that buffer effectiveness for removing bacteria from runoff ranges widely, and largely depends on the infiltration rate of buffer soils. The literature seems to indicate that bacteria removal efficiencies can be high for light to moderate rainfall events but significantly decrease during heavy rainfall events when buffer soils become saturated and runoff passes through the buffer rather than into the soil.
<u>Effectiveness Score = 2</u>

MM-5. MM-5 is also considered a treatment measure and, similar to MM-4, should not be considered a standalone measure for achieving the needed bacteria loading reductions. Any of the LID practices that include capturing and filtering runoff through a soil column (artificial or natural) has shown some degree of effectiveness. Those would include bioretention facilities, rain gardens, and permeable pavement. However, during heavy rainfalls, they too are susceptible to bypassing when soils become saturated. Considering the relatively low permeability of native soils in the lower CNR Watershed, LID measures should be equipped with underdrains.
<u>Effectiveness Score = 2</u>

MM-6. Sewer extension into all of the lower CNR neighborhoods would virtually eliminate human waste as a bacteria source for the lower CNR, assuming all homeowners and businesses connected to the sewer. The 1994 Sewerage Feasibility Study showed that the existing surplus capacity at the YSD treatment plant can easily absorb new sanitary sewer flows from neighborhoods on the south side of the river, suggesting that it has more than enough surplus

capacity for all the lower CNR neighborhoods. The high rate of BOD and TSS removal at the treatment plant itself is expected to remain unchanged.

Based on BSLC model calculations, sewer extension into the neighborhoods on the south side of the river only has the potential to remove approximately 76% of the total bacteria load coming from the priority subwatersheds. This is due to the relatively large population of septic systems in these neighborhoods and the relatively older age of these septic systems as compared to those in the neighborhoods on the north side of the river (Table 9-3). As discussed in Section 10.1, completion of a detailed septic system survey (MM-1) would provide more specific information to estimate the actual bacteria load reduction by identifying the number of failing septic systems. Even with sewer on the south side of the river, MM-1 and MM-2 should be implemented in the priority subwatersheds on the north side of the river if water quality standards are to be achieved.
Effectiveness Score = 5

11.2 Implementability

The implementability evaluation considers the practical and regulatory obstacles to constructing the mitigation measures as well as their level of acceptance by watershed residents. Based on the implementability evaluation, each mitigation measure is given a score of between “1” and “5” (“1” being least implementable and “5” being most implementable).

MM-1 and MM-2. The science and engineering behind septic system inspection, design, and construction are well-established. The Town Code Enforcement Office is responsible for enforcing the State Subsurface Wastewater Disposal Rules. Licensed Site Evaluators are already familiar with the soils in the lower CNR area and experienced septic installers are widely available.

Septic systems are the only means of sewage disposal currently available in the lower CNR neighborhoods, so public acceptance and familiarity with them is high. Since the septic systems are located on private property, landowner permission is required for onsite inspections. Because of the high cost of septic system replacement, some landowners could be reluctant to allow inspections for fear their system is failing and they would be required to then pay the replacement cost.

The Town of York has adopted a septic system pumping ordinance requiring that systems be pumped out at intervals of no longer than five years. Effective enforcement of the ordinance is dependent upon the availability of staff for tracking pumping histories of each system, notifying landowners of their responsibilities, and taking legal action should landowners fail to follow through.
Implementability Score = 4

MM-3. Compliance with the Animal Control Ordinance as it pertains to dogs and the proper disposal of their waste is largely voluntary. Proper disposal of dog waste on private property is entirely voluntary. The key to successful implementation of MM-3 is public education. The Town, YWD, YSD, schools, CNRA, and other related organizations could all participate in the

education effort. Signs and literature needed to create public exposure would be easily obtainable.
Implementability Score = 3

MM-4. Currently, vegetated stream buffers between many of the developed properties and the lower CNR and its tributaries are either nonexistent or are deficient. Provided relevant resource protection rules are followed and the appropriate permits are obtained where they are applicable, buffers are relatively simple to construct. Advice on plantings is available from organizations such as the York County Soil and Water Conservation District (YCSWCD). Level spreader design information is also available from the YCSWCD or through resources available online. They can be either do-it-yourself projects or installed by professional landscapers. Resistance to MM-4 could come from landowners concerned about losing their view (although grass buffers could be used as an alternative) or are reluctant to give up some of their lawn.
Implementability Score = 3

MM-5. Successful implementation of MM-5 would also be dependent on wide public acceptance. By its nature, LID should be implemented throughout a watershed for it to have any measureable effect. While rain gardens can be designed and constructed by landowners, LID practices such as bioretention facilities would normally require the services of design professionals and excavation contractors. The Town could construct practices within the right-of-way but space would likely always be a limiting factor. Low permeability native soils would restrict practices that employ infiltration of rainwater, necessitating underdrains and associated drainage outlets in some cases.
Implementability Score = 2

MM-6. With respect to existing infrastructure, the YSD treatment plant currently has sufficient surplus capacity to take sewage from neighborhoods located on both the north and south sides of the lower CNR. In addition, a force main was added when the Shore Road Bridge was recently rebuilt so neighborhoods on the north side are now more accessible for sewer. With respect to engineering studies and design, a feasibility study for extending sewer into the neighborhoods on the south side of the river has been conducted but would need to be updated. More recently, drawings and other construction documents for extending the sewer to the Camp Neddick Campground (Main Street/Shore Road project) was prepared and put out to bid. As a result, some of the engineering needed to extend the sewer into the neighborhoods on the south side has been performed. At a minimum, there is an understanding of sewer infrastructure needs. Based on the number of contractors (eight) that bid on the Main Street/Shore Road project, there are many qualified contractors available for sewer construction. Public resistance to sewer projects appears to be the major obstacle, primarily due to cost. There is also a public perception that mistakenly blames the YSD treatment plant outfall for contributing to the bacteria problem in the CNR.
Implementability Score = 3

11.3 Cost

Table 11-2 presents rough cost estimates for mitigation measures per unit or per project as applicable. Based on the cost evaluation, each mitigation measure is given a score of between "1" and "5" ("1" being most expensive and "5" being least expensive) assuming they are fully implemented and property owners bear the cost of design and construction for infrastructure improvements to and/or on their property.

Table 11-2
Bacteria Mitigation Measure Cost Estimates

MM-1 and MM-2		MM-3		MM-4		MM-5		MM-6	
Item	**Cost ($)**	**Item**	**Cost ($)**	**Item**	**Cost ($)**	**Item**	**Cost ($)**	**Item**	**Cost ($)**
Survey[1]	20 K	Signs	1 K	Spreader[4]	100	RG[6]	1 K	CNC[9]	2 M
Replacement[2]	15 K	Literature	500	Plants[5]	500	BR[7]	4 K	CR[10]	4 M – 6 M
Pumping[3]	300					PP[8]	6.50		

Notes: RG= rain garden; BR=biorention facility; PP=permeable pavement; CNC=Cape Neddick Campground; CR=Clark Road

[1] Includes outreach to community, septic survey, and cost estimation follow-up.
[2] Replacement of a single system.
[3] Pump-out and inspection cost every 3-5 years.
[4] Contractor cost per 10 linear feet.
[5] Contractor cost per 1,000 ft^2
[6] Do-it-yourself residential rain garden without underdrain
[7] Contractor-installed residential bioretention basin with underdrain
[8] Contractor-installed permeable asphalt per square foot with underdrain
[9] Sewer extension down Main Street and Shore Road to Camp Neddick Campground
[10] Sewer extension down Main Street, Shore Road to bridge, and Route 1A to Clark Road including side streets.

Cost evaluation scoring:

- MM-1 and MM-2 Score = 2
- MM-3 Score = 5
- MM-4 Score = 4
- MM-5 Score = 3
- MM-6 Score = 1

The estimated costs for MM-3, MM-4, and MM-5 could be significantly reduced through the contribution of time and materials from volunteers. Cost reductions could also be realized by sharing resources between organizations, town departments, and homeowners. For example, homeowners could share the costs of MM-4 (Vegetated Stream Buffers) and MM-5 (LID Retrofits) by creating generic designs, obtaining commitments from landowners to build them on their properties, and going out to bid to build them all as part of a single project. Consequently, the scoring of MM-3, MM-4, and MM-5 could change dramatically by incorporating these cost-saving measures.

11.4 Evaluation Conclusions. Scores that were assigned to the mitigation measures from the effectiveness, implementability, and cost evaluations are listed in Table 11-3 along with an overall score. The scores are based only on professional judgement and should only be used as a general guide when considering the relative merits of the mitigation measures and how their implementation should be prioritized.

Table 11-3
Bacteria Mitigation Measure Scores

Mitigation Measure	Effectiveness	Implementability	Cost	Overall Score
MM-1 and MM-2	4	4	2	10
MM-3	4	3	5	12
MM-4	2	3	4	9
MM-5	2	2	3	7
MM-6	5	3	1	9

Table 11-3 shows that MM-3 (Management of Pet Waste) scored the highest of the mitigation measures, largely because of its potential effectiveness and low cost. Accordingly, it should be given a high priority. The scoring also indicates that MM-1 and MM-2 received the highest score for reducing sources of human bacteria, and work on a septic survey should be initiated immediately to determine the actual scope of septic system failures within the priority subwatersheds. MM-6 would only be initiated in the event the septic survey finds that conditions are not favorable for septic system replacement, either because of field conditions or economic conditions, or both. The two treatment alternatives, MM-4 and MM-5, should be initiated as soon as willing landowners are identified. However, the emphasis should be placed on MM-4 not only because it is more easily implemented and has a lower cost, but because of the other benefits it can provide to both the landowner and the riparian habitat.

The results of the evaluation shown in Table 11-3 also indicate the preference of mitigation measures that prevent the release of bacteria into the environment (i.e., MM-1, MM-2, MM-3, and MM-6) over those mitigation measures designed to capture bacteria after they have escaped into the environment (MM-4 and MM-5). As discussed in the effectiveness evaluations for MM-4 and MM-5, there is considerable uncertainty as to their effectiveness under the range of environmental conditions (e.g., heavy rainfall versus light rainfall) that they would be subjected to, even if they were constructed to exact specifications. Consequently, MM-4 and MM-5 should only be considered if they are used to complement mitigation measures that prevent the release of bacteria, as opposed to being used as standalone measures.

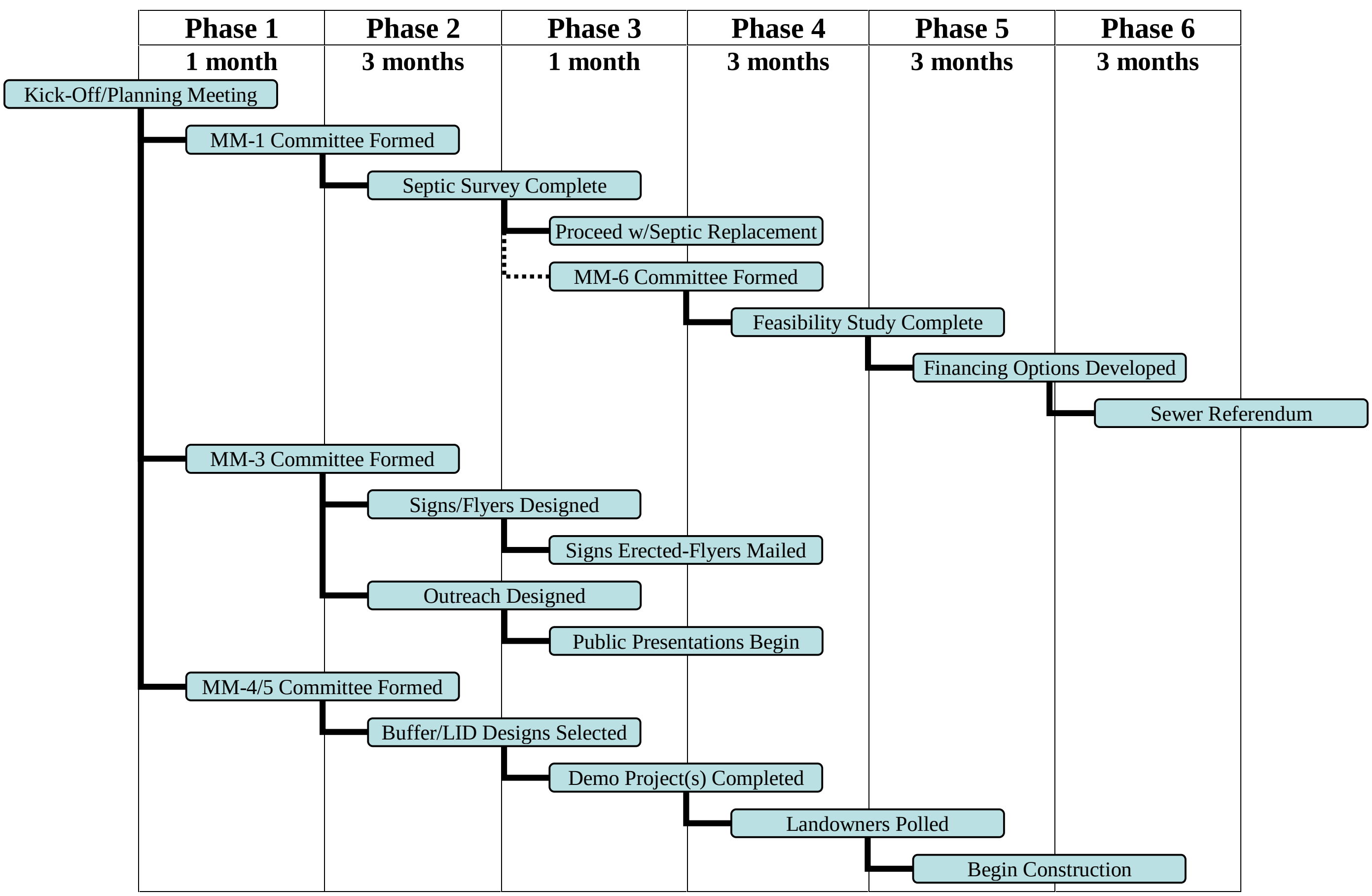
12. PHASED IMPLEMENTATION OF BACTERIA MITIGATION MEASURES

This section presents a proposed schedule for phasing in mitigation measures, identifies milestones and decision points, defines the role of the public, and proposes a program for measuring the success or failure of mitigation measures. This section also satisfies the fifth through ninth criteria from the list of nine EPA criteria (see Subsection 2.1) for a WBMP.

12.1 Proposed Implementation Schedule, Decision Points, and Interim Milestones

Figure 12-1 shows proposed phases for implementation of the mitigation measures along with an estimated period of performance for each phase. The estimated periods of performance should be considered very preliminary as it is assumed that the steering committees will prepare schedules that best suit their respective requirements. Milestones occur at the end of each phase. A decision point occurs at the end of Phase 3, when it will be decided whether to proceed with septic system replacements or redirect efforts towards MM-6 and the extension of sewer into the lower CNR neighborhoods. If that happens, and assuming a sewer referendum passes at the end of Phase 6, design and construction of the sewer extension would begin.

Figure 12-1
Proposed Implementation Schedule with Milestones



12.2 Public Information and Participation Process

Public participation in implementation of mitigation measures is crucial as illustrated in Figure 12-1. The kick-off/planning meeting would serve to share information with the public and to elicit support for the mitigation measures. Members of the public would also be asked to volunteer on steering committees for implementation of MM-1, MM-3, and MM-4/5. It is not anticipated that a steering committee would be needed for implementation of MM-2 since a septic pumping ordinance is already in place and is being enforced. A steering committee for MM-6 would only be necessary if the septic system survey shows that replacement of systems is not feasible. Regardless, the public would need to be involved throughout the implementation process both as members of committees and as participating stakeholders for the process to be successful.

12.3 Proposed Implementation Monitoring for Measuring Success or Failure

The success or failure of mitigation measures can be measured using a variety of metrics including public participation in the process, distribution of educational material, remediation of known bacteria sources, adoption of bacteria treatment measures, and changes in water quality.

Public participation can be measured by:

- Number of attendees at public meetings;
- Citizen involvement on steering committees;
- Percentage of homeowners who respond to requests for permission to perform septic surveys; and
- Incorporation of water quality science in school curriculum.

Distribution of educational material can be measured by:

- Number of signs erected explaining threat to water quality from pet waste;
- Number of households receiving flyers on pet waste;
- Number of households receiving septic pumping notices; and
- Website hits on CNR project webpage on the Town or CNRA websites.

Remediation of known bacteria sources can be measured by:

- Number of septic system inspections;
- Number of septic system replacements;
- Survey of dog owners at Cape Neddick Beach; and
- Percentage of home owners complying with septic pumping ordinance.

Adoption of bacteria treatment measures can be measured by:

- Number of demonstration Vegetated Buffers or LID retrofits constructed;
- Length of Vegetated Buffers installed along the river and tributaries;
- Number of LID retrofits constructed; and
- Percentage of subwatersheds draining to a Vegetated Buffer or LID retrofit.

Changes in water quality can be measured by:

- Ongoing water quality monitoring at CNR-01 (Shore Road Bridge) and Cape Neddick Beach by the YPRD.
- Periodic monitoring of lower CNR tributaries and main stem per the 2012 sampling protocol (dry and wet conditions) by trained volunteers and/or town staff.
- Periodic monitoring using microbial source tracking, optical brightener and/or other emerging strategies to gather bacteria data that is specific to human and domestic animal sources.

In response to a resident's report that possible increases in aquatic plant growth has occurred over the past few years in the main stem of the river above Clark Road bridge, follow-on nutrient sampling in this area would be appropriate. Samples could be collected at CNR-02 and CNR-01-1 on the main stem and at the tributaries CNR-13 and CNR-15, and analyzed for total phosphorus (lowest detection limit), nitrate, and total nitrogen (TKN). Sampling could be done every four to six weeks from April through October including dry period sampling and wet period sampling immediately following rain events. This additional data could be used to evaluate whether there may be some correlation between nutrient levels and observed plant growth.

13. POTENTIAL FUNDING AND TECHNICAL ASSISTANCE SOURCES

Funding and technical assistance is potentially available from a number of sources. Each funding source has its own restrictions on how its funds are spent, so careful examination of funding literature is necessary in order to gain an understanding of what type of projects could be covered by a funding source.

NPS Pollution Control Grants (319). As explained in Section 2.1, this WBMP is structured so that NPS projects implemented consistent with this plan are eligible for Section 319 funding. This is a competitive grant process that is administered by the MEDEP. Eligible organizations include:

- State agencies
- Soil and Water Conservation Districts
- Regional planning agencies
- Watershed districts
- Municipalities
- Nonprofit 501(c)(3) organizations

Types of projects/activities that have been funded by 319 grants include:

- NPS "demonstration" projects that educate the public about NPS pollution mitigation methods;
- Design and construction of vegetated buffers and LID retrofits;
- Signage and educational materials;
- Educators/facilitators that oversee NPS pollution control programs;
- "Youth Conservation Corps" that employ young people to build low technology projects; and
- Surveys to identify sources of NPS pollution.

The 319 Grants require a "match" of funds or in kind services. Organizations experienced with the 319 grant program include the YCSWCD, which has experience with 319 applications and can provide the technical and administrative expertise for project implementation. The time-frame for submitting proposals to the MEDEP for 319 grants is between late April and early June of each year.

Septic System Replacement Funding. The MEDEP also administers the Small Community Grant Program (SCG), which is a potential source of grants to towns to help replace failing septic systems that are polluting a waterbody or causing a public nuisance. An actual pollution problem must be documented in order to qualify for funding. SCG grants can be used to fund from 25% to 100% of the design and construction costs, depending upon the income of the owners of the property and the property's use. Grant applications must be submitted by the municipality in which the owner resides. Applications must be received by the MEDEP by January 31 in order to receive funding in that year.

The Town of York may want to consider other means of assisting residents with replacement of failing septic systems including:

- Administering a loan program funded by taxes levied on future development in the watershed;
- Providing property tax relief for owners meeting certain qualifying criteria; or,
- Acting as an agent for collective bidding on septic system materials (through organizations similar to the Greater Portland Council of Governments).

Sewer Extension Funding. The YSD would be responsible for acquiring sewer extension funding. They were successful in securing financing from the SRF for the rejected Main Street/Shore Road sewer extension (2007). The YSD would likely attempt to finance any future sewer extension projects in part, or whole, by the SRF. The Maine Municipal Bond Bank (MMBB) is the financial manager of the SRF program. The MMBB combines federal, state, and repayment funds to create attractive interest rates, 2% below the market rate, for terms up to 20 years. Other sources of sewer funding that have been used in York and elsewhere include:

- Increase rates of all sewer users. Since this project would benefit more than just the potential sewer users, some of the cost of sewering all or part of the lower CNR could be borne by all sewer users.
- Impose Impact Fees. One-time fee due at the time of sewer connection.
- Payment of a one-time "betterment" fee. Property owners within the sewered area would pay this fee, the amount of which would be based on feet of road frontage or some similar measurement.

Other Potential Funding Sources. In addition to the potential sources of funding and technical assistance discussed above, the following organizations have been involved in funding water quality related projects:

- National Fish and Wildlife Foundation
- Maine Department of Transportation
- USDA National Resource Conservation Service – Farm Bill
- Maine Department of Conservation
- US Fish and Wildlife
- New England Grassroots Environmental Fund
- Richard Saltonstall Charitable Foundation
- Davis Conservation Foundation
- Gulf of Maine Council Action Plan Grants Program
- Gulf of Maine Habitat Restoration Grants Program
- Jessie B. Cox Charitable Trust: A New England Philanthropy
- Maine Community Foundation (Fund for Maine Land Conservation

14. POTENTIAL LEAD ORGANIZATIONS AND AGENCIES

The following organizations would be appropriate for helping to implement this WBMP.

Local/County:

- Town of York for administrative support
- York Water District for technical support and education
- York Sewer District for lab services, technical support, and education
- Cape Neddick River Association for securing grants, volunteer/landowner recruitment, and education
- York Land Trust for publicity and land conservation advice
- York Rivers Association for publicity
- York County Soil and Water Conservation District for administrative and technical support

State:

- Maine Department of Environmental Protection for grant funding/administration and technical support
- Maine Department of Marine Resources for education

Federal:

- US Environmental Protection Agency for education
- Wells National Estuarine Research Reserve for education and publicity

Contact information for the above organizations is provided in Appendix A.

Acronyms

AWT	advanced wastewater treatment
BOD	biological oxygen demand
BSLC	bacteria source load calculator
cfu	colony forming unit
CNR	Cape Neddick River
CNRA	Cape Neddick River Association
DMR	Department of Marine Resources
DO	dissolved oxygen
EPA	Environmental Protection Agency
gpm	gallons per minute
LID	low impact development
MEDEP	Maine Department of Environmental Protection
MGD	million gallons per day
mg/l	milligrams per liter
MHB	Maine Healthy Beaches
ml	milliliters
MM	mitigation measure
MMBB	Maine Municipal Bond Bank
MPN	most probable number
MS4	municipal separate storm sewer system
NPS	nonpoint source
SRF	State Revolving Loan Fund
SCG	Small Community Grant Program
TMDL	total maximum daily load
TSS	total suspended solids
WBMP	watershed-based management plan
WNERR	Wells National Estuarine Research Reserve
WQV	water quality volume
YCDD	York Community Development Department
YCSWCD	York County Soil and Water Conservation District
YPRD	York Parks and Recreation Department
YSD	York Sewer District
YWD	York Water District

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Appendices

A. Watershed Partners

B. 2007 – 2011 Water Quality Data

C. 2012 Non Bacteria Water Quality Data

D. Sample Pet Waste Brochure

Cape Neddick River Watershed-Based Management Plan

Appendix A: Watershed Partners

FEDERAL:

- U.S. Environmental Protection Agency
  - Source of 319 NPS grants to states and overseer of TMDL process among other functions
  - Contact: Sandra (Sandy) Fancieullo, NPS Coordinator
    U.S. EPA, Region I, OEP06-1
    5 Post Office Square
    Boston, MA 02109-3912
    Phone: (617) 918-1566
    Fax: (617) 918-1505
    E-Mail: fancieullo.sandra@epa.gov

- Wells National Estuarine Research Reserve
  - Learning center and public advocacy organization for responsible management of estuaries
  - Contact: Chris Feurt, Coastal Training Program Coordinator
    Wells National Estuarine Research Reserve
    342 Laudholm Farm Rd
    Wells, ME 04090
    Phone: (207) 646-1555
    Fax: (207) 646-2930
    E-Mail: cfeurt@wellsnerr.org

STATE:

- Maine Department of Environmental Protection
  - Administrator of NPS Program (including 319 grants) and TMDL process among other functions
  - Contact: Norm Marcotte, Nonpoint Source Grants (319) Program
    Maine Department of Environmental Protection
    17 State House Station
    28 Tyson Drive
    Augusta, ME 04333-0017
    Phone: (207) 215-6277
    Fax: (207) 287-7826
    E-Mail: norm.g.marcotte@maine.gov

STATE (cont.):

- Maine Department of Marine Resources
  - Manages and enforces rules concerning shellfish growing areas and establishes prohibited zones around overboard discharges among other functions
  - Contact: Timothy Bennett, Water Monitoring & Shellfish Growing Areas
    Department of Marine Resources
    PO Box 8
    West Boothbay Harbor, ME 04575-0008
    Phone: (207) 633-9408
    Fax: (207) 633-9579
    E-Mail: timothy.d.bennett@maine.gov

COUNTY:

- York County Soil and Water Conservation District
  - Technical and educational resource for protection of watersheds from NPS pollution
  - Contact: Melissa Brandt, District Manager
    21 Bradeen St, Suite 104
    Springvale, ME 04083
    Phone: (207) 324-0888 ext. 214
    Fax: (207) 324-4822
    E-Mail: melissabrandt@yorkswcd.org

LOCAL:

- York Department of Community Development
  - Provider of code enforcement, planning, geographic information services, and community development services and administers watershed protection projects
  - Contact: Stephen Burns, Community Development Director
    186 York Street
    York ME, 03909
    Phone: (207) 363-1007
    Fax: (207) 363-1009/1019
    E-Mail: sburns@yorkmaine.org

- York Department of Parks and Recreation
  - Responsible for management of parks and beaches among other functions
  - Contact: Michael Sullivan, Director
    Grant House, 200 US Route 1
    Phone: (207) 363-1040
    Fax: (207) 351-2967
    E-Mail: msullivan@yorkmaine.org

LOCAL (cont.):

- York Sewer District
    - Responsible for the sanitary sewer system and operation of the wastewater treatment plant on the south shore of Cape Neddick Harbor
    - Contact: Timothy Haskell, Superintendent
      York Sewer District
      PO Box 1039
      21 Bayhaven Road
      York Beach, ME 03910
      Phone: (207) 363-4232
      Fax: (207) 363-6701
      E-Mail: thaskell@yorksewerdistrict.org

- York Water District
    - Responsible for watershed protection upstream of Chase's Pond Dam, water treatment at the Josiah Chase Filtration Plant, and distribution of clean drinking water
    - Contact: Don Neumann, Superintendent
      York Water District
      PO Box 447
      86 Woodbridge Rd
      York, ME 03909
      Phone: (207) 363-2265
      Fax: (207) 363-7338
      E-Mail: dneumann@yorkwaterdistrict.org

NON-GOVERNMENTAL ORGANIZATIONS:

- Cape Neddick River Association
    - River advocacy group that has been involved in public outreach, water quality monitoring, and lobbying town government for this WBMP.
    - Contact: Linda Scotland
      Cape Neddick River Association
      E-Mail: info@capeneddickriver.org

- York Land Trust
    - Preserves natural resources through land conservation by collaborating with individual landowners, state and local governments, and other conservation organizations
    - Contact: Doreen MacGillis, Executive Director
      The York Land Trust, Inc.
      PO Box 1241
      York Harbor, ME 03911
      Phone: (207) 363-7400
      E-Mail: info@yorklandtrust.org

NON-GOVERNMENTAL ORGANIZATIONS (cont.):

- York Rivers Association
    - River advocacy group that focuses on the York River but advocates for the protection of all York rivers
    - Contact: York Rivers Association
PO Box 1106
York Harbor, ME 03911-1106
E-Mail: info@yorkrivers.org

Cape Neddick River Watershed-Based Management Plan

Appendix B: 2007 – 2011 Water Quality Data

Cape Neddick River Water Quality Testing

2007 - 2011

Compiled from the Cape Neddick River Water Quality Testing Reports

	2007			2008			2009			2010			2011			Site Totals					
Test Site	Pass	Fail	Total	Pass	Fail	Total	Pass	Fail	Total	Pass	Fail	Total	Pass	Fail	Total		Pass	% Pass	Fail	% Fail	Total
CNR-01	5	1	6	3	5	8	5	4	9	11	3	14	9	1	10	CNR-01	33	70%	14	30%	47
CNR-01-1													2	2	4	CNR-01-1	2	50%	2	50%	4
CNR-02	0	6	6	1	4	5	5	5	10				3	2	5	CNR-02	9	35%	17	65%	26
CNR-02-1													0	8	8	CNR-02-1	0	0%	8	100%	8
CNR-02-2													1	4	5	CNR-02-2	1	20%	4	80%	5
CNR-03	5	1	6	2	2	4	7	2	9				0	4	4	CNR-03	14	61%	9	39%	23
CNR-04	3	3	6	1	3	4	4	6	10	8	6	14	0	3	3	CNR-04	16	43%	21	57%	37
CNR-05	1	5	6										1	4	5	CNR-05	2	18%	9	82%	11
CNR-06				2	6	8	3	7	10				0	3	3	CNR-06	5	24%	16	76%	21
CNR-06-1													1	3	4	CNR-06-1	1	25%	3	75%	4
CNR-06-2													1	3	4	CNR-06-2	1	25%	3	75%	4
CNR-07				3	4	7	5	4	9						-	CNR-07	8	50%	8	50%	16
CNR-08				2	4	6	3	6	9						-	CNR-08	5	33%	10	67%	15
CNR-09				1	7	8	4	5	9	7	7	14	0	3	3	CNR-09	12	35%	22	65%	34
CNR-09-1													0	1	1	CNR-09-1	0	0%	1	100%	1
CNR-09-2													0	3	3	CNR-09-2	0	0%	3	100%	3
CNR-10				0	6	6	4	5	9	5	8	13	3	0	3	CNR-10	12	39%	19	61%	31
CNR-11				0	5	5	7	3	10				0	5	5	CNR-11	7	35%	13	65%	20
CNR-11-1													2	2	4	CNR-11-1	2	50%	2	50%	4
CNR-12				2	1	3	5	4	9						-	CNR-12	7	58%	5	42%	12
CNR-13				3	3	6	6	4	10				0	4	4	CNR-13	9	45%	11	55%	20
CNR-14				1	3	4	6	4	10				0	8	8	CNR-14	7	32%	15	68%	22
CNR-15				0	2	2	6	4	10				0	5	5	CNR-15	6	35%	11	65%	17
CNR-15-1													4	1	5	CNR-15-1	4	80%	1	20%	5
CNR-15-2													1	4	5	CNR-15-2	1	20%	4	80%	5
CNR-16													0	4	4	CNR-16	0	0%	4	100%	4
CNR-17													0	4	4	CNR-17	0	0%	4	100%	4
CNR-18													1	4	5	CNR-18	1	20%	4	80%	5
CNR-19													1	3	4	CNR-19	1	25%	3	75%	4
CNR-19-1													2	2	4	CNR-19-1	2	50%	2	50%	4
Ann. Total	14	16	30	21	55	76	70	63	133	31	24	55	32	90	105		168		248		416
	47%	53%		28%	72%		53%	47%		56%	44%		30%	86%			40%		60%		

Cape Neddick River Watershed-Based Management Plan

Appendix C: 2012 Non Bacteria Water Quality Data

Sample	Date	Nitrate (mg/L)	T Phos (mg/L)	TKN (mg/L)	Zinc (mg/L)	Lead (mg/L)	Nickel (mg/L)	Copper (mg/L)	SC/Sal
Main Stem									
CNR-19	5/9/2012	<0.05	<0.1	<0.25	0.016	<0.001	<0.002	<0.003	60/0.02
	7/10/2012	0.061	<0.1	<0.25	<0.01	<0.001	<0.002	<0.003	68/0.03
CNR-02	5/9/2012	0.054	<0.1	<0.25	0.015	<0.001	<0.002	<0.003	127/0.06
	7/10/2012	0.19	<0.1	0.39	<0.01	<0.001	<0.002	<0.003	203/0.1
CNR-01	5/9/2012	0.095	<0.1	<0.25	0.014	<0.001	0.0026	<0.003	3467/1.83
	7/10/2012	<0.05	<0.1	<0.25	0.0146	<0.001	0.00565	0.003	42900/38.9
Zone 2 Tribs									
CNR-15	7/10/2012	0.66	<0.1	0.26	0.0131	**0.0021**	0.0036	**0.0041**	734/0.36
CNR-13	5/9/2012	0.068	<0.1	<0.25	0.018	<0.001	<0.002	<0.003	80/0.03
	7/10/2012	0.31	<0.1	<0.25	<0.01	<0.001	<0.002	<0.003	104/0.05
CNR-12	5/9/2012	0.84	<0.1	<0.25	0.016	<0.001	<0.002	<0.003	402/0.19
CNR-11	5/9/2012	0.082	<0.1	0.38	0.016	**0.00136**	<0.002	<0.003	89/0.04
	7/10/2012	0.13	<0.1	0.62	0.0166	**0.0041**	0.0024	**0.0036**	271/0.13
CNR-10	5/9/2012	0.52	<0.1	0.29	0.018	<0.001	<0.002	<0.003	660/0.32
	7/10/2012	0.23	<0.1	0.45	0.0232	**0.00665**	0.0046	**0.0044**	6360/3.5
CNR-09	7/10/2012	<0.05	0.15	0.58	0.026	**0.00535**	0.0078	**0.0065**	43920/28.4
CNR-08	5/9/2012	0.28	<0.1	<0.25	0.017	<0.001	<0.002	<0.003	889/0.44
	7/10/2012	0.052	<0.1	<0.25	<0.01	**0.0014**	0.0026	<0.003	7632/4.2
CNR-07	5/9/2012	0.14	<0.1	0.27	**0.0525**	<0.001	0.0024	**0.008**	1078/.057
	7/10/2012	0.81	0.12	1.1	0.0302	**0.0022**	0.0033	**0.004**	34270/21.6
CNR-06	5/9/2012	<0.05	<0.1	0.47	0.018	<0.001	<0.002	<0.003	271/0.13
Zone 1 Tribs									
CNR-05	5/9/2012	0.15	<0.1	<0.25	0.018	<0.001	<0.002	<0.003	270/0.13
	7/10/2012	0.51	<0.1	<0.25	<0.01	<0.001	<0.002	<0.003	651/0.32
CNR-05-D	5/9/2012	0.091	<0.1	<0.25	0.02	<0.001	<0.002	<0.003	275/0.13
	7/10/2012	0.21	<0.1	<0.25	0.0126	<0.001	<0.002	<0.003	760/0.37

Notes: 1. May water samples were also analyzed for antimony, arsenic, beryllium, cadmium, chromium, mercury, selenium, silver and thallium. All results were below the detection limit for these elements.
2. SC/Sal = Specific Conductance (umhos/cm^2)/Salinity
2. July water samples were analyzed for copper, lead, nickel, zinc
3. < "X" = Compound not detected above reporting limit "X".
4. Values in Bold are above Ambient Water Quality Criteria.

Cape Neddick River Watershed-Based Management Plan

Appendix D: Sample Pet Waste Brochure