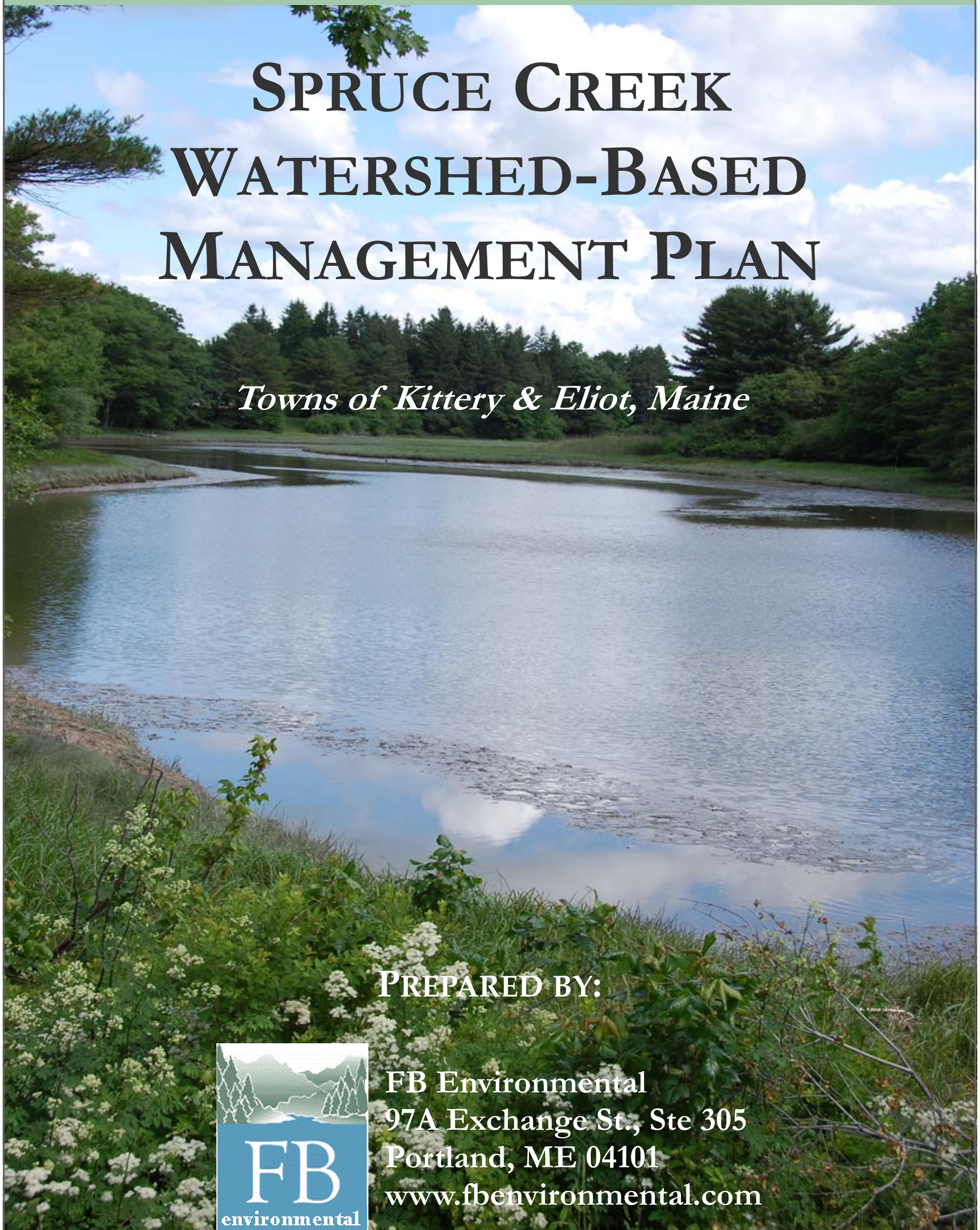

SPRUCE CREEK WATERSHED-BASED MANAGEMENT PLAN

Towns of Kittery & Eliot, Maine

PREPARED BY:

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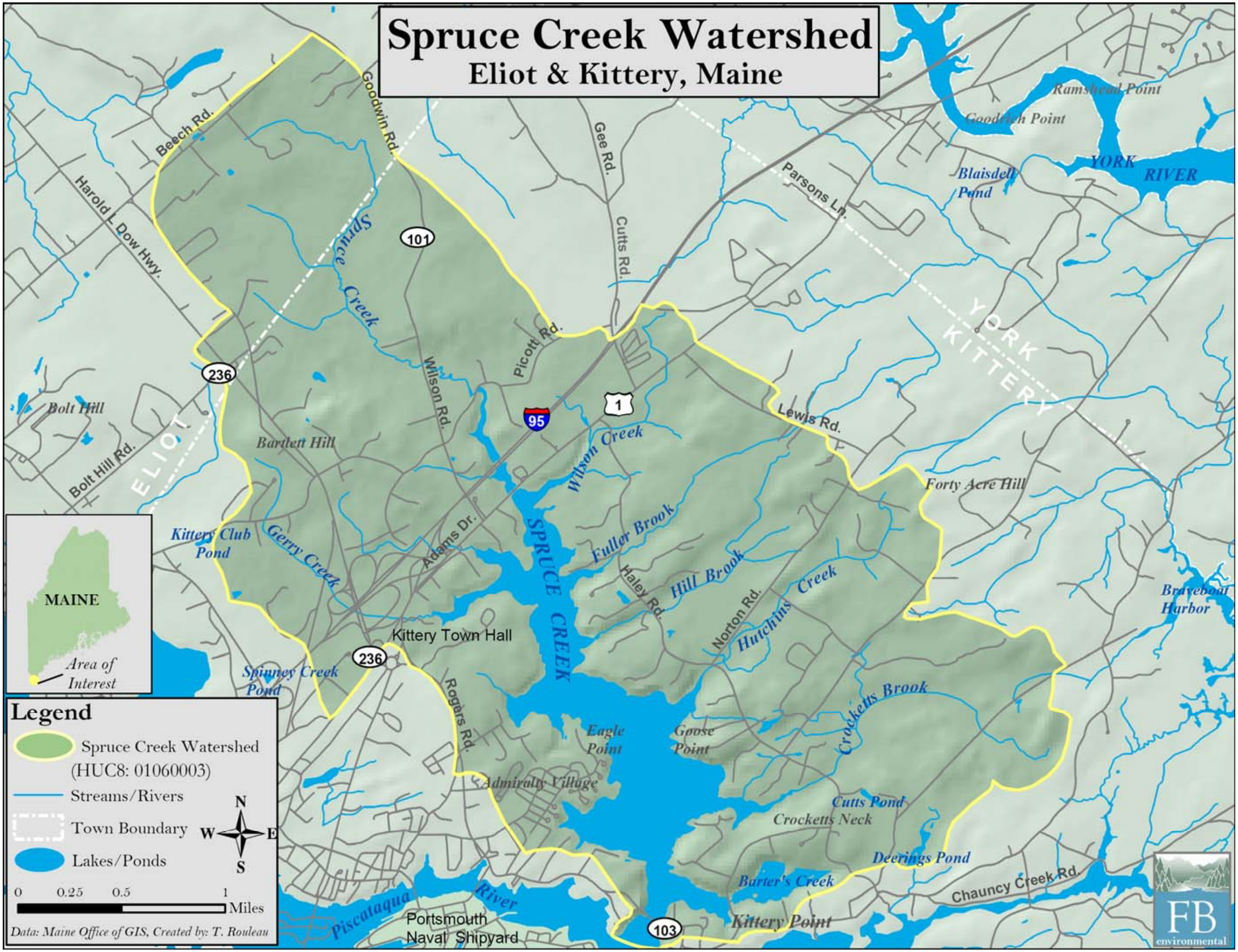
MAY 2008



Spruce Creek Watershed
Eliot & Kittery, Maine
Legend
Spruce Creek Watershed (HUC8: 01060003)
Streams/Rivers
Town Boundary
Lakes/Ponds
0 0.25 0.5 1 Miles
N S W E
Data: Maine Office of GIS, Created by: T. Rouleau
MAINE
Area of Interest
SPRUCE CREEK
Spruce Creek
Wilson Creek
Fuller Brook
Hill Brook
Hutchins Creek
Crocketts Brook
Gerry Creek
Barter's Creek
Cutts Pond
Deerings Pond
Kittery Club Pond
Spinney Creek Pond
Blaisdell Pond
YORK RIVER
Piscataqua River
Brave Boat Harbor
Ramshead Point
Goodrich Point
Forty Acre Hill
Bartlett Hill
Bolt Hill
Eagle Point
Goose Point
Crocketts Neck
Kittery Point
Admiralty Village
Kittery Town Hall
Portsmouth Naval Shipyard
YORK
KITTERY
ELIOT
Goodwin Rd.
Beech Rd.
Harold L Dow Hwy.
Bolt Hill Rd.
Gee Rd.
Cutts Rd.
Parsons Ln.
Picott Rd.
Wilson Rd.
Adams Dr.
Lewis Rd.
Haley Rd.
Norton Rd.
Rogers Rd.
Chauncy Creek Rd.
101
236
95
1
103
FB environmental

SPRUCE CREEK WATERSHED-BASED MANAGEMENT PLAN

Prepared by FB Environmental Consulting
in cooperation with the Towns of Kittery and Eliot,
and the Spruce Creek Association

May 2008

Contact:
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Cover photo: View of Spruce Creek from I-95 crossing in Kittery. (Rachel Bell, 2007)

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Photo: Spruce Creek, looking downstream from US Rte. 1 crossing. (Rachel Bell, 2007)

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1. EXECUTIVE SUMMARY

1.1 Plan Background

Due to poor water quality, Spruce Creek is listed in Maine's 2006 Integrated Water Quality Monitoring and Assessment Report (303d) as impaired under Category 5-B-1: Estuarine & Marine Water Impaired by Bacteria (**TMDL** required) for **nonpoint source pollutant** sources. This body of water is also identified by the Maine DEP as one of 17 **Nonpoint Source Priority Coastal Watersheds** due to bacterial contamination, low dissolved oxygen, toxic contamination, and a compromised ability to support commercial marine fisheries. Additionally, the Spruce Creek watershed is listed by the DEP as one of seven coastal watersheds most at risk from development in the state.

Development of a watershed management plan is a key step in Watershed Management, leading to restoration of a polluted or otherwise impaired waterbody. To this end, the Spruce Creek Association (SCA) has been working with the Towns of Kittery and Eliot to develop a watershed-based management plan, which will serve as a blueprint for restoring and protecting Spruce Creek. Incorporating input from stakeholders, this plan identifies the most pressing problems in the Spruce Creek estuary and establishes goals, objectives, and actions for resolving them. The management plan also contains strategies for monitoring progress and financing implementation. The Spruce Creek Watershed-Based Management Plan (WBMP) will be reexamined and revised on a regular basis to ensure that the goals, objectives, and specific actions continue to address the most pressing problems.

TMDL -
is an acronym for Total Maximum Daily Load, which represents the total amount of a pollutant (e.g., bacteria) that a waterbody can receive while still meeting water quality standards.

Nonpoint Source (NPS) Pollution -
is polluted runoff that cannot be traced to a specific origin or starting point, but accumulates from overland flow from many different watershed sources.

Nonpoint Source Priority Watersheds -
The NPS Priority Watersheds List, developed in 1998, identifies those watersheds in Maine where State and Federal agencies will coordinate activities and seek to provide assistance to local groups for the purpose of developing or implementing watershed management plans. The title is given to watersheds based on four priorities established by the State: the assessment of their value, the amount of impairment or threat to water quality and aquatic habitat, the likelihood that watershed management objectives will be met, and the amount of public support for the watershed and its management.

1.2 Plan Goals and Objectives

The goal of the Spruce Creek Watershed-Based Management Plan is to **safeguard and enhance the watershed, its water quality and its diversity of habitats and wildlife as part of a regional landscape so that present and future generations can benefit from the full potential of its natural resources.** The following objectives have been identified to achieve the long-term goals established for the watershed (for full description of these objectives, see Section 7):

- Protect and restore vegetated buffers, to reduce NPS pollution and improve water quality.

- Control invasive plants.
- Reduce bacteria loads / open shellfish beds.
- Treat impervious surfaces / minimize stormwater impacts.
- Increase conservation lands within Spruce Creek watershed.
- Continue water quality assessment and evaluation.
- Reduce existing heavy metal contamination.

1.3 Description of Watershed

The Spruce Creek watershed (HUC 01060003) is an ecologically and economically significant estuarine resource in southern Maine supporting a diverse array of recreational and commercial water-based activities. Spruce Creek originates in Eliot where three small, unnamed brooks converge. As it enters Kittery it becomes tidal. After passing under the I-95 and Route 1 bridges, the creek widens and flows in a south and southeasterly direction for two miles through Kittery, to the Piscataqua River, which forms the border between Maine and New Hampshire. The watershed area consists of a variety of land uses including forested, developed, agricultural and wetlands.

View of Spruce Creek from Duncan Road., off Rte. 103. (Photo: Rachel Bell, 2007)

1.4 Existing Conditions

Under the Federal Clean Water Act, all water bodies have a classification based on standards established at the state level. The freshwater portion of Spruce Creek is classified as Class B and the estuary portion SB by the State of Maine. Class B is the 3rd highest classification. The Act states that Class B waters "shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing, 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" (Classification of Maine Waters 2004). Class SB waters "must be of such quality that they are 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 and, navigation and as habitat for fish and other estuarine and marine life" (Classification of Maine Waters 2004). Per Federal guidelines, States must ensure that the habitat of B and SB waters are characterized as unimpaired. Spruce Creek does not meet its state water quality classification based on the results of the following monitoring activities:

- ***2005-2007 SCA Water Quality Monitoring:*** Results of water quality monitoring conducted by SCA from 2005 to 2007 have indicated a high variability in dissolved oxygen readings. The two upstream sites, sites 5 and 6 (see **Map 9, Appendix B**), have had **dissolved oxygen measurements of less than 85% saturation** 21% and 20% of the time, respectively.

- ***2005 Maine Healthy Beaches Bacteria Monitoring:*** Over the course of 11 sampling events at three sites, site 1 **exceeded the enterococci EPA limit for marine waters** 4 times and sites 2 and 3 exceeded the limit 3 and 2 times, respectively (see **Map 9, Appendix B**), .

- ***1989-2007 Department of Marine Resources Fecal Coliform Monitoring:*** In July of 2005, clam samples from Spruce Creek were found to have **very high fecal coliform concentrations**. High fecal coliform counts were found at all three sampling locations at least once during the 2005 and 2006 sampling seasons. As of February 1, 2008, all of Spruce Creek was classified as "Prohibited" for shellfish harvesting (see **Map 10, Appendix B**).

- ***1987 Maine Department of Environmental Protection Metals Analysis:*** The results MDEP metals sampling in Spruce Creek show that both **lead and mercury are found in above normal levels**. Other metals present include silver, cadmium, chromium, copper, nickel, zinc, aluminum, and iron.

- ***1995-1996 MDEP and WNERR Dissolved Oxygen Study:*** Results showed that Spruce Creek had **low dissolved oxygen** compared to other marine systems in the study and had mean % DO saturation values well below 100% (Kelly and Libby 1995).

1.5 Threats to Water Quality

Threats to the water quality of Spruce Creek stem from both nonpoint and point sources of pollution in the watershed.

In 2005, an **NPS Pollution Survey** was carried out to recognize and locate sources of polluted runoff (NPS pollution) in the watershed. The survey team found 197 sites of nonpoint source pollution in the watershed, and 70% of the sites included issues with nutrients. The results identified the following as the major nonpoint pollution sources:

- Nutrients (141 sites)
- Lack of vegetated buffers (60 sites)
- Trash and debris (60 sites)
- Flow restrictions (29 sites)
- Impervious surfaces (64 sites)

Other NPS pollution sources documented included: septic systems, ATV/recreational paths, trail/foot paths, construction sites/construction site debris, pet/animal waste, possible pesticide/fertilizer use, storm drains, and pipe discharges.

In the same year, Northern Ecological Associates was hired by the Maine State Planning Office to conduct an **Inventory** of **Habitat Restoration Opportunities**. The purpose of the survey to identify, evaluate, and document potential habitat and environmental restoration opportunities in, and directly adjacent to, specific areas along the southern Maine coast, including Spruce Creek. The following water quality degradation sources were noted in the Spruce Creek watershed:

- Cleared land (48 sites)
- Land use activity (48 sites)
- Docks/jetties/piers (34 sites)

In 2004, a **Stormwater Assessment and Retrofit Inventory** of U.S. Route 1 within the commercial area in Kittery was undertaken by Hillier & Associates, Inc. The analysis was assigned by the Maine State Planning Office to determine the extent and location of various publicly-owned stormwater inputs to the Spruce Creek watershed and to identify possible stormwater best management practice retrofit locations within the area. The inventory revealed 21 stormwater outfalls discharging pollutants.

Point sources of pollution in the watershed include four known overboard discharge sites. Two are licensed and on the Maine Departments of Environmental Protection's Priority for Removal list and two were previously undocumented until 2006.

Finally, septic systems are also a threat to the water quality of Spruce Creek since much of the watershed is not on public sewer and soils in the watershed are often not well suited to septic systems.

1.6 Water Quality Goals

The overall water quality goals are to ensure that Spruce Creek meets minimum Class B and SB standards and is useful and healthy for drinking, recreation, fish, birds, and other wildlife now and in the future.

1.7 Recommended Management Strategies

Watershed partners can review and adjust activities, regulations, and community awareness to reduce the occurrence of new sources of pollution in the Spruce Creek watershed and can also implement a variety of techniques, referred to collectively as **Best Management Practices (BMPs)**, to manage nonpoint pollution inputs. Section 8.1 of this plan outlines recommended BMPs that can be applied to NPS problems identified in the Spruce Creek watershed.

Best Management Practices (BMPs)- are techniques, measures or structural controls implemented to reduce potential pollutant generation and/or facilitate pollutant removal in stormwater runoff. There are three general types of BMPs: structural, non-structural and housekeeping (USEPA 1999).

Thought of as the "hard" BMPs, **structural BMPs** are engineered and constructed systems used to treat stormwater at either the point of generation or the point of discharge to the stormwater system or receiving waters. Soil reinforcement techniques include the use of geotextile fabrics and rip rap. Water conveyance BMPs include culvert installation, and vegetated/riprap waterways. Water Detention BMPs include sediment pond construction, sediment traps, and construction dewatering (MDEP 2006).

Non-structural BMPs can be thought of as "soft" BMPs. These include a range of management and development practices designed to limit the conversion of rainfall to runoff and to prevent pollutants from entering runoff at the source of runoff generation. Examples of non-structural BMPs include temporary soil stabilization techniques such as mulching and vegetating loose soil at a construction site, but may also include education to prevent the generation of pollutants in runoff (USEPA 1999). BMPs used to prevent sediment movement include sediment barriers, check dams, and dust control techniques. Permanent soil stabilization BMPs in this category include grading and slope protection, establishing vegetation and mulching, and using vegetated buffers.

A third, underutilized BMP category includes the **Managerial and Housekeeping BMPs**. Managerial BMPs involving dust control and fertilizer and pesticide management are also important. Housekeeping BMPs include street sweeping and household hazardous waste disposal (MDEQ 1998), cleaning out clogged culverts, and ensuring establishment of vegetation. Recommended BMPs in the Spruce Creek watershed fall under all three categories, yet the majority fall into the non-structural and housekeeping BMPs.

1.8 Implementation, Projected Costs and Funding

Section 9.2 of this plan outlines an Action Plan for the implementation of watershed improvement tasks and includes the responsible parties, potential funding sources, and approximate costs. Action Plan items were developed in collaboration with watershed partners including local town officials, watershed landowners, and SCA members. **Section 9.4** lists potential sources of additional funding.

Aerial view of Kittery and Portsmouth, October 2007. *Spruce Creek flows through Kittery, Maine (left) before draining into the Piscataqua River Estuary (center), near the Portsmouth Naval Shipyard. Portsmouth, New Hampshire can be seen on the right side of the photo.* *(Photo: Phyllis Ford, 2007)*

2. INTRODUCTION

2.1 Why is this plan needed?

Many watershed projects using State of Maine Department of Environmental Protection Section 319 funds follow a community-supported watershed management plan, whether they are designed to protect unimpaired waters, restore impaired waters, or both. Because of Spruce Creek's status as an impaired (TMDL) waterbody, the completion of a Watershed-Based Management Plan (WBMP) is required. The EPA requires preparation of the plan to ensure that 319 funded projects make progress towards restoring NPS impaired waters. The 319 grant program is intended to support NPS projects which aim to prevent or reduce nonpoint source pollutant loadings entering water resources so that beneficial uses of the water resources are maintained or restored. According to the Maine Department of Environmental Protection, NPS projects help local communities recognize water pollution sources in watersheds and take action to restore or protect clean water. A grant-eligible NPS project is implemented in a specific watershed to help restore or protect a lake, stream, or coastal water that is impaired or considered threatened by polluted runoff. Spruce Creek has been officially designated by the state of Maine as a nonpoint source priority watershed due to bacterial contamination, low dissolved oxygen, toxic contamination, and compromised ability to support commercial marine resources.

2.2 How was the plan developed?

This plan was developed using a watershed-approach. Using a watershed approach to restore impaired waterbodies is beneficial because it is a holistic approach in which local stakeholders are actively involved in selecting management strategies that will be implemented to solve problems in the watershed. The Spruce Creek WBMP worked within this framework by using a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement selected actions. The outcomes of this process are documented within this Spruce Creek WBMP.

2.3 Who was involved?

The Spruce Creek WBMP is part of a long-term effort initiated and supported by a number of towns, agencies, organizations, and individuals including: the Towns of Kittery and Eliot, Spruce Creek Association (SCA), York County Soil & Water Conservation District (YCSWCD), Maine Department of Environmental Protection (MDEP), United States Environmental Protection Agency (USEPA), local businesses, Wells National Estuarine Research Reserve (WNERR), Maine Department of Marine Resources (DMR) and Kittery Land Trust (KLT).

In April of 2007, the Town of Kittery contracted with FB Environmental Consulting in Portland to oversee the watershed management plan process. A series of forums and meetings, critical to the development of this plan, followed:

- A Spruce Creek Watershed Community Forum was hosted by the Wells NERR and the Spruce

Creek Association on November 29, 2006. The forum was attended by 30 individuals from towns, organizations, and State agencies. Participants defined and prioritized the Spruce Creek proposed project goals and objectives.

- A Spruce Creek WBMP Steering Committee meeting was held on June 4, 2007. The 19 participants in this meeting further prioritized the project goals and objectives.
- On July 24, 2007, a second Spruce Creek WBMP Steering Committee meeting was held in which 16 participants discussed a proposed outline for the Plan.
- On October 15, 2007, the draft Plan was presented for comments and discussion at a Spruce Creek WBMP Steering Committee Meeting.
- In November, 2007 and April 2008, the draft Plan was reviewed by watershed stakeholders, and stakeholder comments were incorporated into the plan document.

2.4 Who should read this plan?

Because the Spruce Creek WBMP defines existing and future problems that need to be addressed, any group that influences or is affected by water quality, habitat management ,and land use decisions should read this report. Municipalities and local groups in and around the Spruce Creek watershed should use this plan as a foundation for local action, from stream restoration projects to ordinance changes. State and federal agencies can use this plan to enhance understanding of local watershed conditions and as a basis for coordinating basin planning, permitting, and regulatory decisions.

2.5 How is this plan organized?

EPA Guidance lists nine components required to be included in watershed-based management plans to restore TMDL-listed waters impaired by nonpoint source pollution. The following describes the nine required elements and where they are found in this plan:

1. An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBMP (and to achieve any other watershed goals identified in the WBMP), as discussed in item (2) immediately below is located in **Sections 5.1 and 5.2**.
2. An **estimate of the load reductions expected** for the management measures described under (3) below is described in **Section 8.3**.
3. A **description of the NPS management measures** that will need to be implemented to achieve the load reductions estimated under (2) above (as well as to achieve other watershed goals identified in this WBMP), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan are located in **Section 8.2** and **Section 6.2**, respectively.
4. An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan is described in **Section 9.4**.
5. An **information/education component** that will be used to enhance public understanding of the project is located in **Section 9.5**.

6. A **schedule for implementing the NPS management measures** identified in this plan is in **Section 9.2**.
7. A **description of interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented can be found in **Section 9.3**.
8. A **set of criteria** that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards water quality standards; and if not, the criteria for determining whether this WBMP needs to be revised is in **Section 9.7**.
9. A **monitoring component** to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (8) above is can be found in **Section 9.6**.

View of Spruce Creek from Newson Rd.
(Photo: Rachel Bell, 2007)

3. DESCRIPTION OF THE WATERSHED

3.1 Location

The Spruce Creek watershed covers 9.8 square miles (6,112 acres) in the towns of Kittery (90% - 5,498 acres) and Eliot (10% - 611 acres) in the southernmost corner of the State of Maine. The headwaters of Spruce Creek are located in Eliot and the creek flows in a southeasterly direction through Kittery for 2 miles before eventually emptying into the Piscataqua River, which forms the border between Maine and New Hampshire. Spruce Creek is fed by six small fresh water streams: Wilson Creek, Fuller Brook, Hill Creek, Hutchins Creek, Crockett's Brook, and Barter's Creek. Near its confluence with the Piscataqua River, the Creek is a coastal, tide-dominated system with a significant estuarine area approximately 2.25 miles long and a half-mile wide. This watershed is part of the Atlantic Coastal Plain with the land from the coast to several miles inland appearing as flat or gently undulating terrain. Spruce Creek is influenced by the tidal flow from the Piscataqua River and at low tide, approximately 2.5 square miles of clam flats are exposed. The marine environment consists of mud flats, high salt marsh, and ledge. Farther up the estuary toward U.S. Route 1, much of the creek is classified as low salt marsh. This area is rich in marine life, particularly soft shell clams.

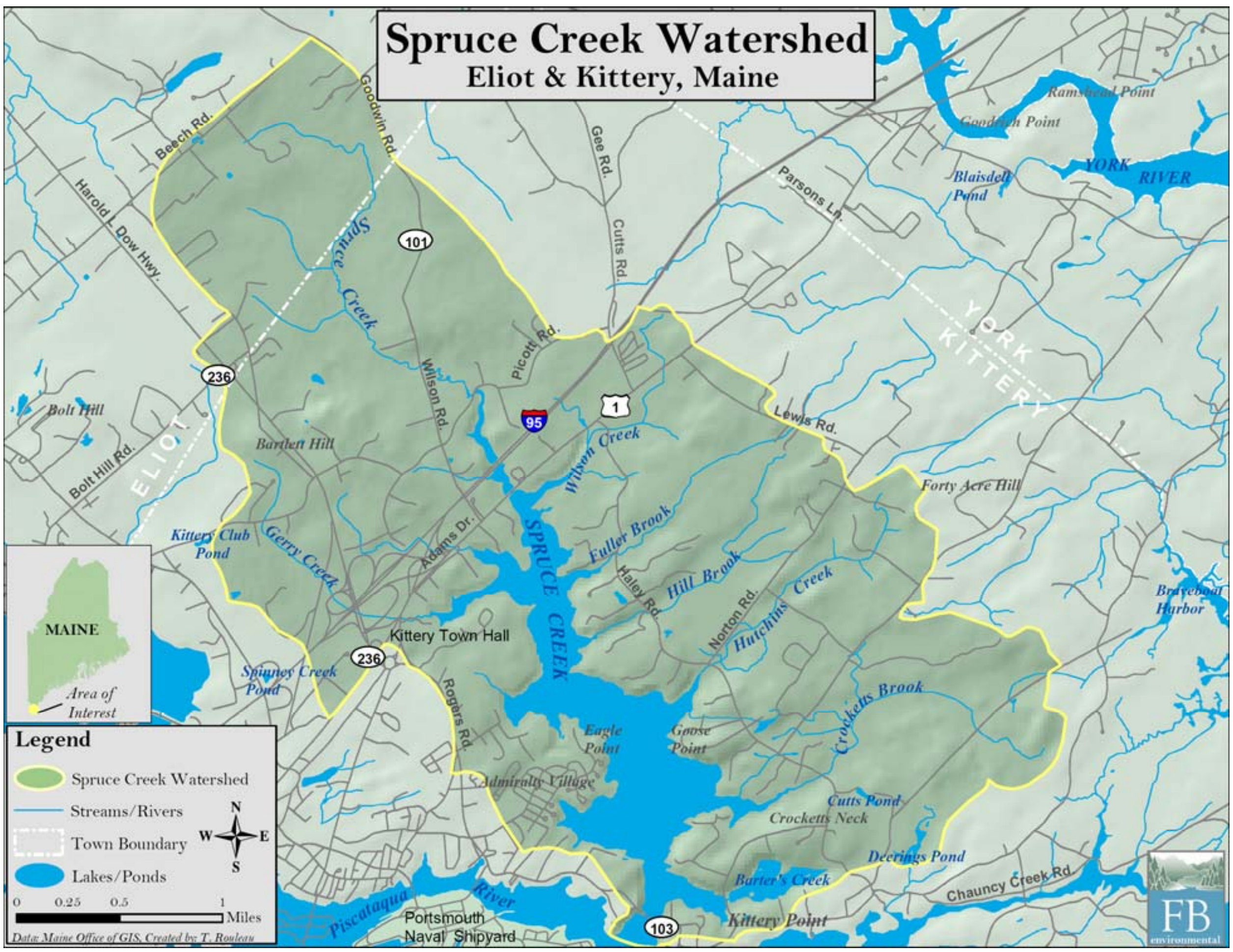


Figure 3.1.1. *Map of Spruce Creek watershed.*

3.2 Population and Demographics

Spruce Creek is located in York County, Maine's fastest growing county. As of 2006, the Southern Maine county's population was 206,590, up about 20,000 people, or more than 10 percent, since 2000. In fact, 33 percent of Maine's total population growth over the last six years has occurred in York County. From 2000 to 2006, the population growth rates for Kittery and Eliot were 5.9% and 8.3% respectively. This compares with 10.6% for York County, and 3.8% for Maine as a whole (SMRPC 2007). Like most coastal New England communities, Kittery and Eliot draw their existence from the sea and the presence of a deep water harbor. These historic seacoast towns consist of economically diverse neighborhoods, working waterfronts, natural habitats and resources, rural landscapes, and commercial businesses. However, the rapidly growing population, and accompanying development, may have an important influence on the character and environment of these communities.

Although the population growth rates in Kittery and Eliot are lower than the county average, development pressure is steadily increasing. Kittery issued 350 building permits between 2000 and 2005, and Eliot issued 221 during the same period. According to the Southern Maine Regional Planning Commission (SMRPC), the town of Eliot has a residential growth cap in place, allowing for a maximum of 48 new units per year. Kittery currently has no cap in place (2007).

U.S. Route 1, leading to Kittery.
(Photo: Rachel Bell, 2007)

With both I-95 and U.S. Route 1 entering Maine in Kittery, the community serves as the gateway to Maine. Over the past twenty years, this role has greatly changed and expanded with the development of the factory outlet centers along U.S. Route 1. As of 2007, were a number of controversial development projects pending in Kittery, including renovations to the stretch of U.S. Route 1 between Love Lane and the rotary, and plans for a 25,500-square-foot community center on Kenneth R. Emery Field. In 2008, the Maine DOT plans to begin renovating portions of U.S. Route 1 in Kittery, widening the road and shoulders and adding granite-curbed sidewalks.

Population demographics for Kittery and Eliot are listed in Table 3.2.1 below.

Table 3.2.1. *2000 Population Demographics in Kittery and Eliot, Maine. (U.S. Census Bureau, 2000)*

	Population under the age of 18	Population aged 18-24	Population aged 25-44	Population aged 45-64	Population over the age of 65	Median Age	Median Household Income	Per Capita Income	Population below poverty line
Kittery	21.9%	7.4%	30.7%	24.8%	15.2%	39	$45,822	$24,153	7.6%
Eliot	25.8%	1.7%	32.6%	27.8%	12.1%	39.7	$52,606	$24,403	5.8%

3.3 Land Use and Land Cover

Land cover in the Spruce Creek watershed is dominated by upland forest, which covers 42% (2578 acres) of the watershed land area. Developed land is the second-largest land cover class, covering 1492 acres (24%) of the watershed and consisting of high intensity development (261 acres), medium intensity development (242 acres), low intensity development (594 acres), developed open space (92 acres), and roads (302 acres). There are approximately 985 acres (16%) of wetlands scattered throughout the watershed. Agricultural land, including crops, hayland and pasture, covers 7% (414 acres), and the remaining 3% is covered by other land uses, including unconsolidated shore, scrub-shrub, and grassland. An extensive retail outlet corridor serving over 3 million shoppers per year is located along U.S. Route 1 and Interstate 95, transecting the Spruce Creek watershed. The east side of the watershed is high density residential, largely served by the Town sewer and containing many impervious surfaces and lawns. The west and north side are mostly rural residential with private septic systems often sited in marginal soils, based on soil data from the Maine Office of GIS. Impervious area covers approximately 11% of the Spruce Creek watershed (**Map 2, Appendix B**). Studies have shown that the percentage of impervious cover (% IC) in a watershed strongly effects the health of aquatic systems because land surfaces that block infiltration of rainwater cause increased amounts of stormwater to run off into gutters, untreated storm sewers or directly to streams. In general, surface water quality declines as imperviousness exceeds 8% of watershed area (MDEP, 2002).

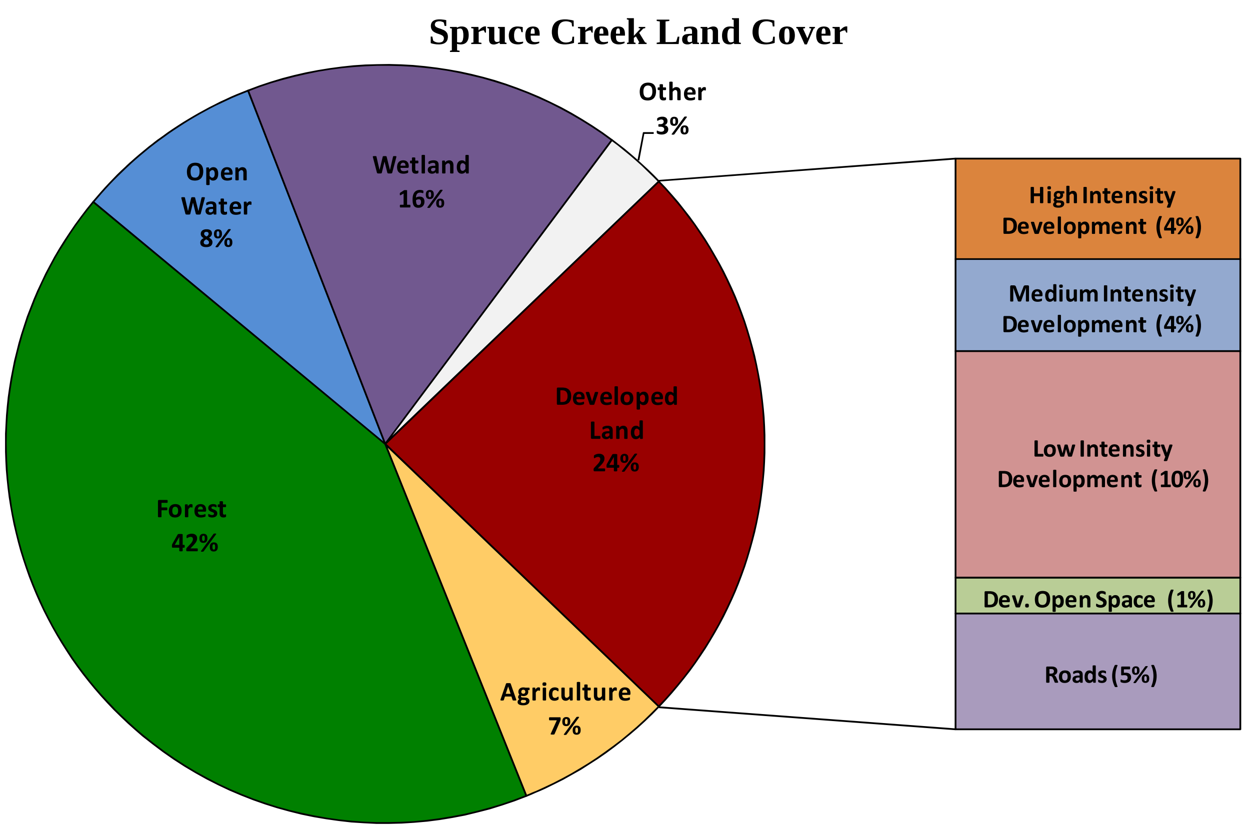


Figure 3.3.1. *Spruce Creek watershed land cover.*

3.4 Physical Features

Topography

Spruce Creek flows primarily north to southeast, originating in Eliot at approximately 60 feet above sea level. Topography in the watershed is characterized by extensive wetlands, with some small hills on the eastern side of Spruce Creek in Kittery, and elevation generally ranging from 20 to 80 feet. The highest point in the watershed is Bartlett Hill (approximately 100 feet), located on the western side of the watershed in the town of Kittery. Slopes in the watershed range from 8 to 15%.

Soils

There are two general soil associations in the watershed: Lyman-Tunbridge-Dixfield and Scantic-Lamoine-Buxton-Lyman. Lyman-Tunbridge-Dixfield soils are predominantly loamy soils derived from glacial till parent materials. Scantic-Lamoine-Buxton-Lyman soils are clayey and loamy soils formed in glaciomarine sediments and loamy till. Smaller areas of peat, mucky peat, silt loam, and gravel are scattered throughout the watershed. Over 40% of soils in the watershed are mapped as hydric, or wet. Rock outcrops are found in the southeast corner of the watershed and on Crockett's Neck and Goose Point. Over 63% (3907 acres) of soils in the watershed are considered poor or very poorly suited to low density development and septic systems.

Additionally, approximately 1,234 acres (20%) of the soils in the Spruce Creek watershed are highly erodible and 2,130 acres (35%) are potentially highly erodible (**Map 3, Appendix B**) (USDA/NRCS and MEGIS 2005). Highly erodible soils have a potential to erode at a rate far greater than what is considered tolerable soil loss and have a higher potential to negatively effect water quality. The potential erodibility of soil is dependant on a combination of factors including rainfall and runoff, susceptibility of the soil to erosion, and slope length and steepness (USDA/NRCS and MEGIS 2005).

3.5 Land Resources

There are approximately 756 acres of conservation land within the Spruce Creek watershed (**Map 5, Appendix B**). Of the conserved land in the watershed, only **216 acres of land are permanently preserved**.

View from the site of State-owned Fort McClary. *(Photo: Rachel Bell)*

Among the non-permanently protected lands in the watershed are 434 acres of land enrolled in Maine’s Current Use Tax programs. The Tree Growth Tax Law and the Farm and Open Space Tax Law were established in the 1970's to prevent property taxes from forcing productive woodlands, farms and significant open spaces into tax delinquency or conversion to development. Under the tree growth and farmland programs, land is assessed depending on its productive value. Only properties that are undeveloped can be enrolled in the Tree Growth and Farm and Open Space Tax Programs. For tree growth classification, the property must be forested, managed according to a forest management plan, and contain at least ten contiguous acres. For farmland classification, the land must be used for agricultural activities, must contain at least five contiguous acres, and the landowner must earn an agricultural income of at least $2,000 annually from the land. In the Spruce Creek watershed, 273 acres are in the tree growth program and 161 acres are in the farmland program. Although not permanent, the Current Use Tax programs can be a useful tool that gives landowners monetary incentives to keep their properties undeveloped, providing a temporary level of protection from development sprawl.

The town of Kittery owns 203 acres, including Roger's Park and Eagle Point which are protected and open to the public. State-owned land in the watershed consists of 18 acres on the site of Fort McClary. This site, located at the southern end of the watershed where Spruce Creek meets the Piscataqua River, is one of Maine's most important historic forts. The remaining 101 acres of conservation land in the Spruce Creek watershed are non-profit land managed by the Kittery Land Trust (KLT).

The Kittery Land Trust "is a not-for-profit organization dedicated to working creatively with landowners, citizens and the Town to conserve and steward important natural areas that improve the quality of life in Kittery now and for the future" (KLT 2007). The land trust manages 4 properties within the Spruce Creek watershed. Two of these properties are owned by the Trust: the Cutts property, 22 acres of forest and wetlands off Haley Road and the Remick property, 88 acres of upland forest off Dennett Road. The remaining two properties are under conservation easement: the Moulton farm, 12-acre farm with buildings and duck pond on Haley Road and the Thompson property, 18 acres of woods at the end of Mill Pond Road on Spruce Creek.

The Kittery Land Trust is also part of the Mount Agamenticus to the Sea Conservation Initiative, a coalition of ten national, regional and local partners representing federal and governmental agencies, statewide land protection organizations, and three local land trusts working to conserve a mosaic of critical lands, waterways and working landscapes in the six-town area between the Tatnic Hills of Wells and Gerrish Island in Kittery Point. The area is the largest unfragmented coastal forest between Acadia National Park and the New Jersey Pine Barrens and is home to numerous threatened and endangered species. The Mt. Agamenticus to the Sea focus area, if protected, would include over 800 acres in the Spruce Creek watershed. However, Spruce Creek itself is not within the proposed protection area.

According to data from the Gulf of Maine (GOM) Program, the Spruce Creek watershed contains over 1,070 acres of critical habitat (**Map 4, Appendix B**). The GOM Program mapped and ranked important fish and wildlife habitat for 91 priority species throughout the Gulf of Maine Watershed, including federally endangered, threatened and candidate species, migratory birds, and waterfowl. Additionally, there are over 350 acres of deer wintering area in the Spruce Creek watershed. (Banner and Schaller 2001)

New England Cottontail.
(Photo: UNH)

In 2004, a study conducted by researchers from the University of New Hampshire (UNH) and the Maine Department of Inland Fisheries and Wildlife (MDIFW) identified a total of five New England Cottontail habitat sites within the Spruce Creek watershed, three in Kittery and two in Eliot (Litvaitis and Jakubas 2004). One site in Kittery, near the intersection of U.S. Route 1 and Haley Road, is one of only six sites in Maine with a sustainable

New England Cottontail population and sufficient habitat area (greater than 25 acres) to support the population (D. Tibbetts, personal communication). There are fewer than 320 New England Cottontail remaining statewide (Litvaitis and Jakubas 2004). The ideal habitat type for New England Cottontail is successional shrubland, such as abandoned farmland. Development is the largest threat to this species as it fragments large blocks of habitat necessary for viable Cottontail populations (D. Tibbetts, personal communication).

3.6 Water Resources

There are over 18 miles of rivers and streams in the watershed. As mentioned earlier, Spruce Creek has six tributaries: Wilson Creek, Fuller Brook, Hill Creek, Hutchins Creek, Crockett's Brook, and Barter's Creek. Other bodies of water in the watershed include 60 acres of lakes and ponds, including 1 unnamed great pond, Cutts Pond, Deering Pond, and Kittery Club Pond. Wetlands in the watershed cover approximately 921 acres, or 16% of the watershed area.

There are no aquifers in the Spruce Creek watershed. Public water is supplied to Kittery by four surface water sources, which are not located within the Spruce Creek watershed. The Distribution Division of the Kittery Water District maintains 1,900,000 gallon tank located in Eliot and a 3,000,000 gallon tank in Kittery.

Spruce Creek at Picot Road. *(Photo: Phyllis Ford, 2007)*

4. BASELINE AND FUTURE CONDITIONS

4.1 Applicable Water Quality Standards

The freshwater portion of Spruce Creek is designated Class B, and the saline portion Class SB, by the Maine Department of Environmental Protection (MRSA Title 38, Chapter 3). Spruce Creek's designated shellfish growing areas are areas of potential shellfish habitat, managed with respect to shellfish harvest for direct human consumption. The following table summarizes the Water Quality standards that are applicable to the various sections of Spruce Creek:

Table 4.1.1. *Spruce Creek Applicable Water Quality Standards.*

Waterbody Class	**Criteria**
Fresh water	
Class B[1]	**Dissolved oxygen:** should be greater than or equal to 7 ppm (or 75% saturation) except for the period critical to spawning of indigenous fish species (Oct 1st – May 14th) when the 7 day mean dissolved oxygen concentration shall not be less than 9.5 ppm. ***E. coli:*** Between May 15th and Sept. 30th, *E. coli* of human and domestic animal origin shall not exceed a geometric mean of 64/100mL or an instantaneous level of 236/100mL.
Estuarine and Marine Waters	
Class SB[1]	**Dissolved oxygen:** should be greater than or equal to 85% at any time. ***E. coli:*** Between May 15th and Sept. 30th, *E.coli* of human and domestic animal origin shall not exceed a geometric mean of 8/100mL or an instantaneous level of 54/100mL .
Coastal Beaches[2]	***Enterococci:*** Between May 15th and Sept. 30th, Failure results from single sample enterococcus level exceeding 104/100mL or a geometric mean of 35/100mL for five samples within a 30-day period.
Shellfish Growing Areas[3]	
Area	**Fecal Coliform**
Approved (Growing Areas affected by Point Sources)	Adverse Pollution Conditions: Geometric mean shall not exceed 14/100mL and estimated 90th percentile shall not exceed 31/100mL.
Conditionally Approved (Growing Areas affected by Nonpoint Sources)	Adverse Pollution Conditions: Geometric mean shall not exceed 14/100mL and estimated 90th percentile shall not exceed 31/100mL .
Restricted (Growing Areas affected by Point Sources and Used as a Source for Shellstock Depuration)	Adverse Pollution Conditions: Geometric mean shall not exceed 88/100mL and estimated 90th percentile shall not exceed 163/100mL.
Conditionally Restricted (Growing Areas affected by Nonpoint Sources and Used as a Source for Shellstock Depuration)	Adverse Pollution Conditions: Geometric mean shall not exceed 88/100mL and estimated 90th percentile shall not exceed 163/100mL.
Prohibited	Geometric mean exceeding 88/100mL and estimated 90th percentile exceeding 163/100mL.

[1] MEDEP 2004; [2] USEPA 1986; [3] Maine DMR 2007

4.2 Summary of Available Data

2005-2007 Water Quality Monitoring

In 2005, the SCA began monitoring dissolved oxygen, salinity, and temperature in Spruce Creek, weekly in 2005 and 2006 and biweekly in 2007, during the months of June through September with a DEP-approved Quality Assurance Project Plan (QAPP). The goal of this monitoring is to establish a water quality baseline to be compared to Maine DEP water quality standards to better understand the Creek's current stress levels. Sampling has been conducted at six sites in the Creek, three sites above the bridge at U.S. Route 1 and three below (**Map 9, Appendix B**) from 2005 to 2007. Table 4.2.1 describes the parameters measured.

Table 4.2.1. *Spruce Creek Water Quality Parameters.*

Description of Spruce Creek Water Quality Parameters		
Data	Units	Description
Dissolved Oxygen (DO) Concentration	mg/l	Since most aquatic organisms such as shellfish and other living resources require oxygen to survive, this is a very important measure of water quality. DO concentrations below 5 mg/l can stress organisms. DO concentrations of around 1 mg/l can result in fish kills.
DO Percent Saturation	% normal maximum	DO saturation percent shows the level of dissolved oxygen as a percentage of the normal maximum amount of DO that will dissolve in water. Colder water can hold more DO than warmer water. Super-saturation (over 100% DO saturation) can occur when the input of oxygen from algae or plants is greater than the transfer of oxygen to the air.
Salinity	ppt (parts per thousand)	Salinity in Spruce Creek comes from the ocean. Therefore, areas closer to the ocean have higher salinities. During periods of low precipitation and river flow, salinity increases as it intrudes further up the Creek, while during wetter periods, salinity decreases. Salinity cycles related to the tides may also be evident in these graphs as salinity increases during flood tides and decreases during ebb tides. Salinity levels are important to aquatic organisms, as some organisms are adapted to live only in brackish or salt water, while others require fresh water. If the salinity levels get too high, the health of freshwater fish as well as grasses can be affected.
Water Temperature	°C	Water temperature is another variable affecting suitability of the waterway for aquatic organisms. If water temperatures are consistently higher or lower than average, organisms can be stressed and may even have to relocate to areas with a more suitable water temperature. Water temperature directly affects the solubility of oxygen.

Dissolved Oxygen: Sampling results show that the downstream stations 1, 2, and 3 have less variability in oxygen saturation than the upstream stations 4, 5 and 6. The variability increases with increasing distance upstream. While stations 5 and 6 have the highest mean measured saturation, they also have a higher frequency of low readings, indicating how variable the measurements were at those stations. This can be typical of tidally influenced waters, where changes in salinity and temperature can result in variable DO levels. Site 5 had dissolved oxygen measurements of less than 85% saturation 21% of the time and site 6 had dissolved oxygen measurements of less than 75% saturation 15% of the time. Based on similar measures of DO at each depth, the water column at each station appears to be fully mixed. This is likely due to the tidal currents and/or shallow depths.

High levels of dissolved oxygen (supersaturation) were noted at all sites, particularly sites 4, 5 and 6, during each sampling season. High oxygen concentrations may be indicative of increased phytoplankton activity and could have a negative effect on aquatic plants and animals.

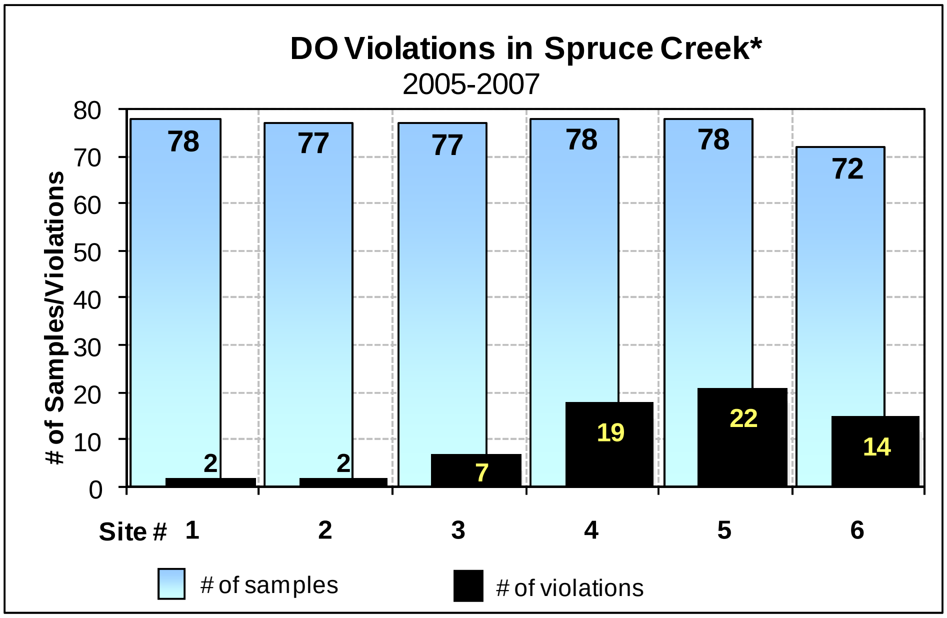


Figure 4.2.1. *DO Violations in Spruce Creek. *Readings taken at 0 meters; violations defined as <85% DO for sites 1-5 and <75% DO for site 6 (see Table 4.1.1).*

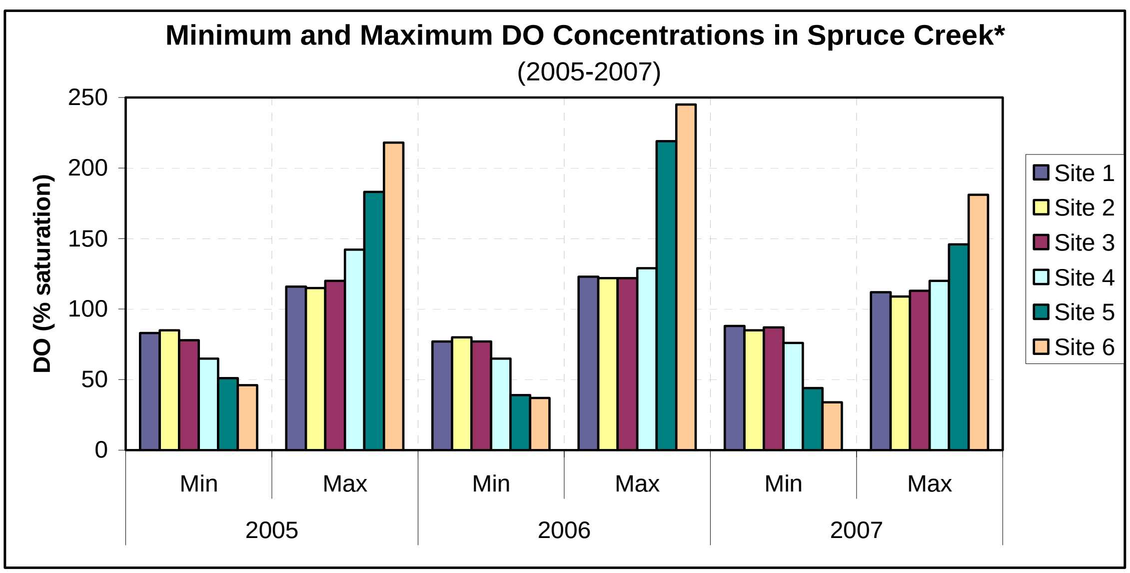


Figure 4.2.2. *DO Variations in Spruce Creek. *Readings taken at 0 meters*

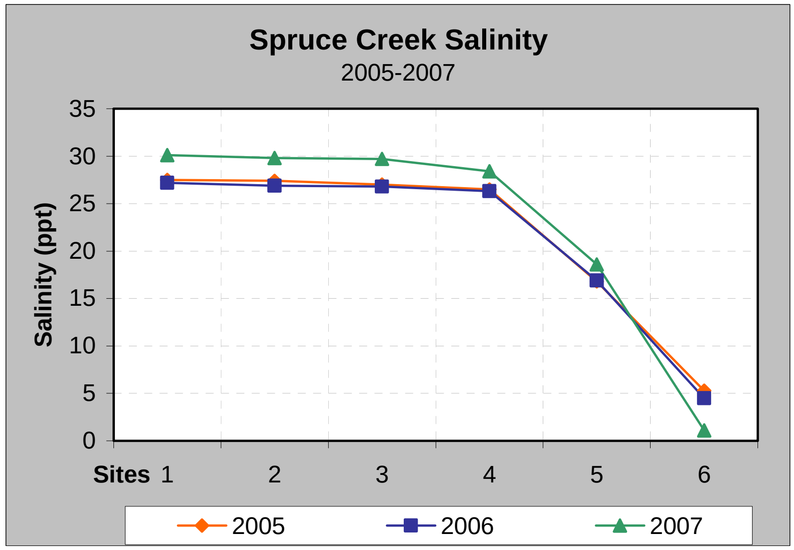


Figure 4.2.3. Spruce Creek Average Salinity.

Salinity: Salinity affects chemical conditions within the estuary, particularly levels of dissolved oxygen in the water. The amount of oxygen that can dissolve in water, or solubility, decreases as salinity increases. The solubility of oxygen in seawater is about 20 percent less than it is in fresh water at the same temperature. In Spruce Creek, all sampling stations appear to be tidally influenced based on salinity measurements. Stations 1, 2, 3, and 4 (**Map 9, Appendix B**) have higher salinity levels in general than the upstream stations, which is due to the downstream stations' proximity to the ocean influences. Figure 4.2.3 (right) shows average salinity at each station during the 2005, 2006 and 2007 monitoring seasons. Measurements have been fairly consistent from year to year.

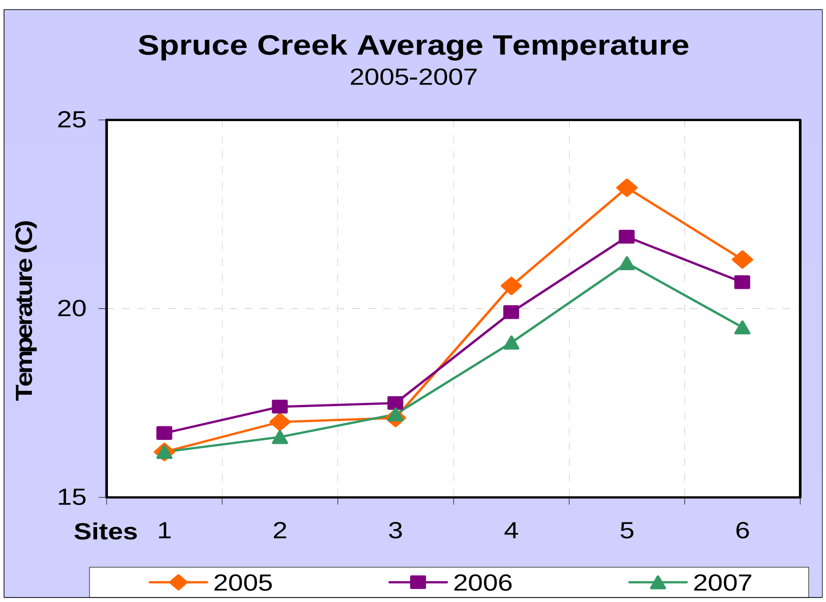


Figure 4.2.4. Spruce Creek Average Temperature.

Temperature: Water temperature is another indicator of how much oxygen can be dissolved into water.Generally, as water temperature increases, the amount of oxygen that can dissolve in the water decreases. In Spruce Creek, the upstream sites 4, 5 and 6 have the highest average temperature and also show the lowest minimum DO readings. The average temperature the three upstream sites has decreased slightly since 2005. Otherwise, average temperatures have remained fairly consistent over the sampling period. The removal of the tidal restriction between sites 3 and 4 in 2006 may have resulted in the slight change in temperature and noted in Figures 4.2.4 and 4.2.3.

2005 Maine Healthy Beaches Bacteria Monitoring

Volunteers training with Maine Healthy Beaches staff at Fort Foster in Kittery. (Photo: P. Ford, 2005)

In 2005, bacteria monitoring was conducted at three sites in the Spruce Creek watershed through the Maine Healthy Beaches Program. Site 1 was located off Bond Road at the convergence Barter and Spruce Creeks, Site 2 was off Eagle Point in Admiralty Village, and Site 3 was located at Roger's Park (see **Map 9, Appendix B**). Water samples were collected each Wednesday morning throughout the summer and tested for enterococci. Enterococci is an indicator organism used in water quality criteria for bacteria. Although these organisms do not cause illness directly, enterococci identifies where fecal contamination has occurred and indicates the presence of other harmful pathogens. According to the EPA recommended criterion for marine recreational waters, Enterococci samples should not exceed a criterion of 104 colonies per 100 ml for a single sample or a geometric mean of 35 colonies per 100 ml based on 5 or more samples collected within a 30-day period (EPA 1986). Over the course of 11 sampling events, site 1 exceeded the EPA limit for marine waters 4 times and sites 2 and 3 exceeded the limit 3 and 2 times, respectively.

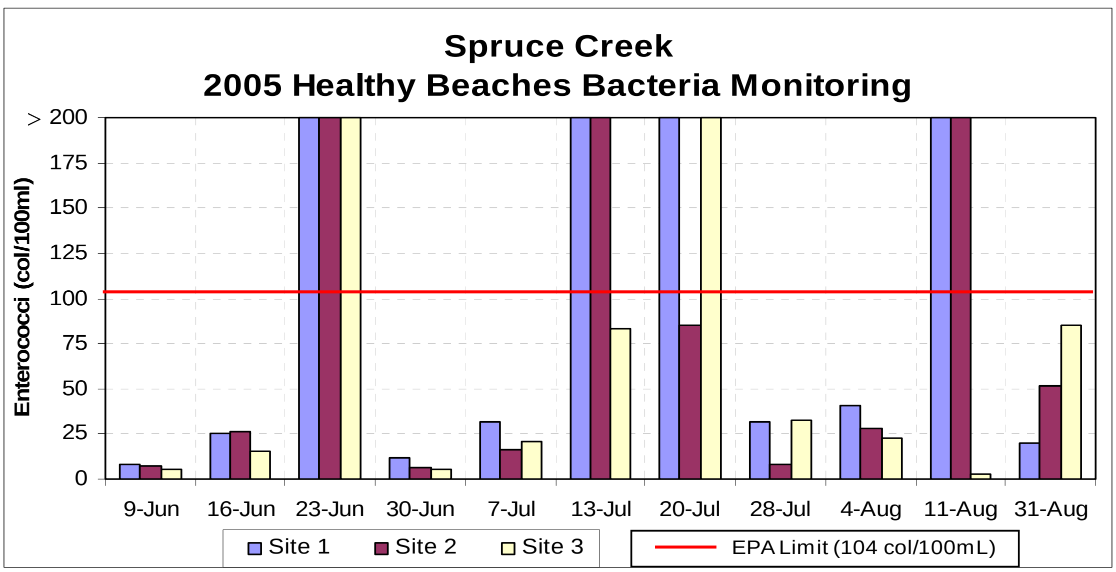


Figure 4.2.5. *MHB Monitoring Results for Spruce Creek, 2005.*

1989-2007 Department of Marine Resources Fecal Coliform Monitoring

The Maine Department of Marine Resources (DMR) has had an ongoing water monitoring program in Spruce Creek since 1989 where fecal coliform levels are tested to ensure safe shellfish harvesting. In 2005 and 2006, additional fecal coliform samples were collected by SCA at five sites above Route 1 in Spruce Creek. (**Map 10, Appendix B**).

Fecal coliform is a type of bacteria that lives in the intestines of warm-blooded animals. The presence of fecal coliform bacteria in a sample indicates that there has been a recent contamination event but does not necessarily indicate that disease-causing bacteria are present. Bacterial results can be greatly influenced by storm events and all sites often have higher than normal levels of bacteria after heavy rainstorms. When only an occasional fecal coliform test at a specific site is high, it is probably due to contamination from animals along the banks or in the water and most likely does not indicate a problem. Consistently high levels at a specific site may indicate a discharge into the water which could have a harmful effect over time and warrants investigation.

In July of 2005, clam samples from Spruce Creek were found to have very high fecal coliform concentrations. High fecal coliform counts were found at all three sampling locations at least once during the 2005 and 2006 sampling seasons (see figure 4.2.6). According to DMR monitoring data, the

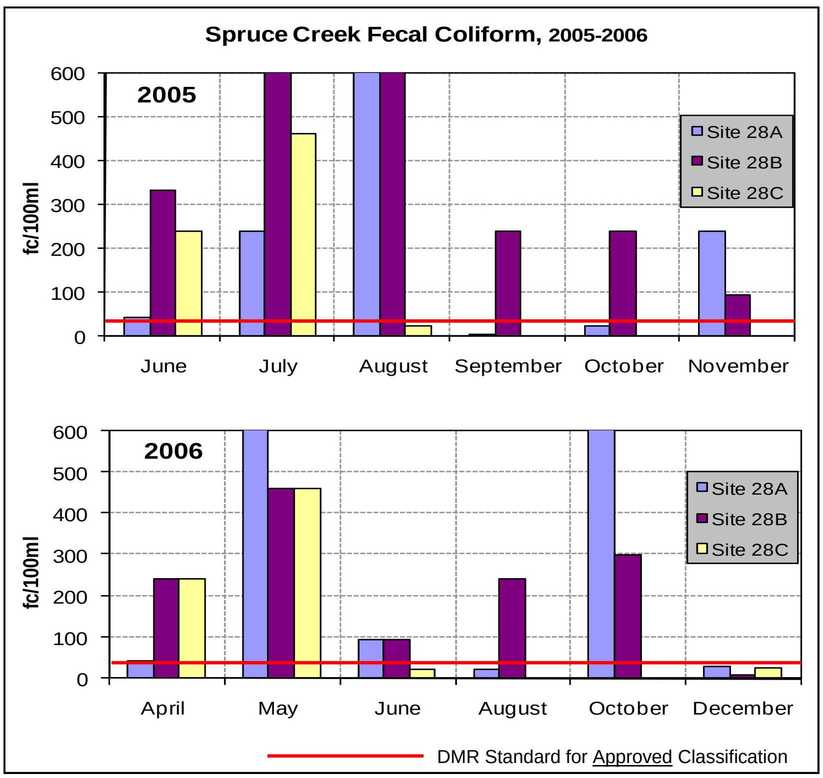
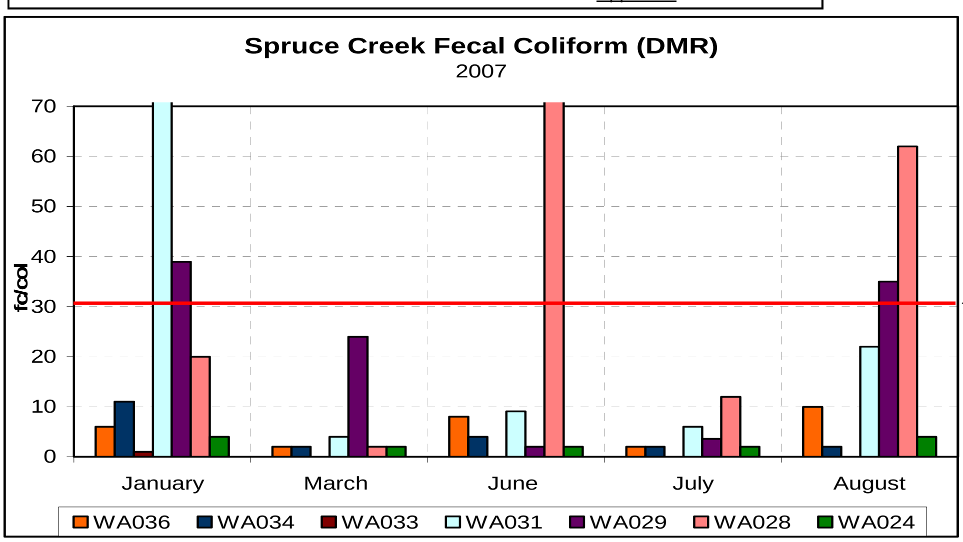


Figure 4.2.6. (left) *Spruce Creek Fecal Coliform. (Samples collected by SCA Volunteers/DMR)*

Note: *Sites 28A, 28B, and 28C correspond to sites WA28, WA27, and WA26, respectively on Map 9 , Appendix B (p.58).*

Figure 4.2.7. (below) *Spruce Creek Fecal Coliform. (Samples collected by Kittery Shellfish Conservation Commission (KSCC) Volunteers/DMR)*



DMR Standard for Approved classification (31 fecal coliforms/100ml) three sampling stations above U.S. Route 1 (WA028, WA029, and WA031) have historically had the highest fecal counts of all of the sampling locations. Sampling results from 2007 show a similar trend (Figure 4.2.7). As of February 1, 2008, all of Spruce Creek was classified as “Prohibited” for shellfish harvesting.

1987 Maine Department of Environmental Protection Metals Analysis

In the late 1980s, Maine Department of Environmental Protection initiated a project to assess the levels and locations of toxic contaminants along the coast. Spruce Creek was chosen as one of the sample sites for their study, "A Decade of Monitoring Toxic Contaminants along Maine's Coast", due to the fact that the mouth of Spruce Creek is directly across from the Jamaica Island landfill Superfund site and the area has a history of industrial uses. The results for the Spruce Creek sampling area show that both lead and mercury are found in above normal levels. Other metals present include silver, cadmium, chromium, copper, nickel, zinc, aluminum, and iron. Results of metal analyses reflect the historic industrial and urban uses of Spruce Creek.

1995-1996 MDEP and WNERR Dissolved Oxygen Study

In 1995 and 1996, the Wells National Estuarine Research Reserve (WNERR) and Maine Department of Environmental Protection (MDEP) monitored Dissolved oxygen levels in a variety of coastal systems in Maine, including Spruce Creek. The goal of the data collection and analysis was to gain insight into factors affecting DO in Maine coastal waters (Kelly and Libby 1995). Samples were collected in 1995 from July to September and additional samples were collected in 1996 in an attempt to further study the importance of freshwater inputs and nutrients in these systems (Kelly 1996). Results from four sampling stations showed that Spruce Creek was “lower in DO than most of the systems” (Kelly and Libby 1995). “Results for the mean % saturation suggested that both Little River and Spruce Creek were significantly different from each other and from the remainder of the systems. These two systems were distinctly heterotrophic, as they had mean % saturation values well below 100%." Similar to the SCA monitoring results, the results of this study show that there is little vertical stratification in the Spruce Creek sampling stations and profile DO readings were generally uniform with depth. DO concentrations also decreased at upstream sites.

4.3 Summary of Spruce Creek Water Quality

Due to the continued poor water quality discussed in **Section 4.2**, Spruce Creek is listed in Maine's 2006 305(b) report as impaired under Category 5-B-1: Estuarine & Marine Water Impaired by Bacteria (TMDL required) for nonpoint pollutant sources. Spruce Creek is also identified by the Maine DEP as a "nonpoint source pollution priority watershed" due to bacterial contamination, low dissolved oxygen, toxic contamination, and a compromised ability to support commercial marine fisheries. Finally, the Spruce Creek watershed is listed by the DEP as one of seven coastal watersheds in the state being "most at risk from development. Table 4.3.1 lists the impairment causes, sources, and possible impacts to the watershed.

Table 4.3.1. *Spruce Creek Impairments and Sources.*

Impairment Causes and Sources		
Causes	**Possible Sources**	**Impaired Uses**
Bacteria	septic systems, human and animal waste, NPS pollution	One concern in both surface and ground waters is the potential degradation of public and private water supply sources. Pathogens reaching a lake or other surface water body may also limit primary contact recreation, such as swimming and result in a compromised ability to support commercial marine fisheries.
Low Dissolved Oxygen (DO)	NPS pollution	Primary concern is a reduction of essential habitat for aquatic organisms.
Toxic Contamination - Heavy Metals	industrial sites	Principle concern in surface water is entry into food chain, bioaccumulation, and toxic effects on habitat for aquatic organisms, other wildlife and microorganisms.

4.4 Water Quality Goals and Objectives

While the primary goal of the Spruce Creek WBMP is to advance locally supported water quality goals, objectives and action strategies for protecting Spruce Creek, the specific water quality goals within the plan are focused on ensuring that Spruce Creek meets minimum Class B and SB standards and is useful and healthy for drinking, recreation, fish, birds, and other wildlife now and in the future.

Spruce Creek from Duncan Rd. ***(Photo: Rachel Bell)***

5. Threats to Water Quality

5.1 Nonpoint Sources

Nonpoint source (NPS) pollution is the largest water quality threat to Spruce Creek. In an effort to document the sources and types of NPS pollution that affect Spruce Creek, SCA, watershed towns, organizations, state agencies, and local volunteers have worked to survey and inventory problem areas in the watershed. Two such studies were initiated in 2005:

Habitat Restoration Inventory

In the spring of 2005 Northern Ecological Associates (NEA) was hired by the Maine State Planning Office, Maine Coastal Program to identify, evaluate, and document potential habitat and environmental restoration opportunities in, and directly adjacent to, specific areas along the southern Maine coast (including Kennebec River, Royal River, Presumpscot River, and Spruce Creek).

Shepard's Cove was noted as a degraded site, due to the presence of invasive plants. *(Photo: NEA)*

The primary objectives of the study were to identify potential restoration sites; screen and prioritize restoration sites; and organize restoration information into a database of potential restoration sites. In Kittery, a secondary objective was to inventory all docks and piers in the Spruce Creek system, regardless of restoration need. The survey team evaluated characteristics within Spruce Creek, along the shoreline bank, and up to 250 feet of the adjacent riparian and buffer areas to identify areas in need of restoration.

The NPS-related survey findings in Spruce Creek are summarized below:

- Ninety-two (92) potential restoration sites were identified in Spruce Creek watershed.
- One hundred fifty-seven (157) individual examples of sources of degradation were observed. The most common sources of degradation were land clearing and land use activity.
- 48 of the 92 sites recorded **cleared land** as a source of degradation.
- 35 of 92 sites recorded **land use activity** as a source of degradation.
- Most sites (87%), had more than one source of degradation.

The report's recommendations suggest that the Towns of Kittery and Eliot work to restore vegetated buffers, educate land owners, improve road crossings, and address invasive species issues. The sites selected by the Habitat Assessment study for restoration opportunities closely mirror those identified in the NPS Watershed Survey (below). (NEA 2005)

Spruce Creek 319 Non-point Source Pollution Survey

The Spruce Creek Watershed Shoreland Survey of NPS Pollution was conducted during the spring and summer of 2005. The majority of the survey was conducted by local volunteers over two days of surveying. The first day of surveying was accomplished with over 50 volunteers who walked designated sections of the watershed by foot on June 4th, 2005 through an organized gathering led by the Wells NERR. The second day of surveying consisted of over a dozen volunteers surveying by boat, canoe, and kayak on June 16th, 2005. The survey involved identifying and recording sources of possible non-point source pollution. (True 2006)

The survey team found 197 sites of nonpoint source pollution, representing over 400 impacts (more than one type of pollution often occurred at each site).

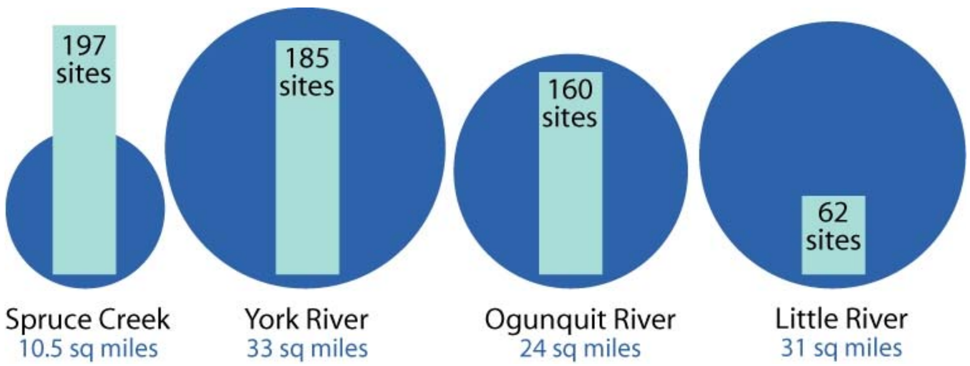


Figure 5.1.1. *Results of the Spruce Creek NPS Pollution Survey show a higher number of NPS sites per square mile when compared to similar surveys in nearby watersheds.*

The most common sources of NPS pollution found in the survey are described below:

- **Nutrients:** Nutrient pollution is the result of excess nutrients accumulating within a waterbody. Excess nutrients in the water can result from erosion, cut vegetation, logging debris left in streams, use of fertilizers, and animal/pet waste. Nutrients can have detrimental effects to the quality of water when added at a rate that is highly excessive then would naturally occur. Excess of nutrients can cause algal blooms and excessive plant and bacteria growth in the water. This not only changes the ecological environment of the subsurface water through the loss of sunlight, but can also cause a depletion in the amount of dissolved oxygen available in the water. **Over 70% (141) of the NPS sites in the survey were cited for a potential for excess nutrients**. Often the potential for nutrients entering the creek was associated with a lack of shoreline vegetation. In a majority of these sites, the vegetated buffer had been reduced to residential lawns.

Survey site with potential nutrient issues in Spruce Creek. (Photo: Phyllis Ford, 2005)

- **Lack of a vegetated shoreland buffer:** Vegetation in the shore land zone (area adjacent to streams, brooks and lakes) helps absorb fertilizers, sediment-laden runoff, and nutrients from developed areas before they enter waterways. Removing vegetation along streams, rivers and lakes may have a number of implications including: direct flow, shoreline and bank erosion, altered stream flow, warming of surface waters-loss of aquatic species, and reduced recreational opportunities. Loss of buffers also decreases the amount of habitat available to native species that depend on this vegetation for breeding and changes the natural scenic beauty of the water course.

The network of tree roots along the shoreline (or buffer zone) stabilize the stream banks, holding soil in place. The above ground network of trunks, branches, leaves and needles alters the way in which precipitation reaches the ground, greatly reducing its erosional impact. The canopy of leaves and needles provides shade to keep water temperature cool and reduce the growth of undesirable algae that can degrade fish spawning and feeding habitats. In the Spruce Creek watershed, **31% (60) of the surveyed sites had either a diminished or incomplete shoreland buffer.**

- **Trash and debris:** Trash and debris is a source of both nutrients and toxics into the watershed. Trash is sometimes thrown directly into creeks, where it washes downstream during periods of heavy rain. Debris pileups and logjams are partly responsible for restricted flow. Debris consists of natural and human-made materials that can obstruct the normal water flow. Debris along streams and creeks interfere with the natural vegetative growth that stabilizes the banks on the waterway.

  In the Spruce Creek NPS survey, **34% (65) of the sites recorded impacts of trash and debris.** Of these sites, roughly 1/3 consisted of both residential and commercial organic lawn/tree maintenance piles (brush piles, grass clippings, log cuttings, etc.) dumped along the bank of a wetland or waterbody of the watershed. Types of trash found along the watershed's banks included approximately 6 dump sites (old and new), rotting decks, a rotting boat, refrigerators, bicycles, furniture, and gallon drum barrels including an old 250 gallon tank as well as a 500 gallon abandoned cement storage tank. Types of trash found in the water itself included old tires, a car transmission, and numerous golf balls.

Trash, such as tires, is one source of pollution in Spruce Creek. (Photo: Phyllis Ford)

- **Impervious surfaces:** Impervious surfaces are hard surfaces such as asphalt, concrete, rooftops, and highly compacted soils. Unlike pervious areas where soil and vegetation absorb rainwater, impervious surfaces are areas that water cannot go through. In many places, as little as 8% impervious cover has been linked to stream impacts, which increases in severity as impervious cover increases (MDEP 2002). The amount of impervious cover in the watershed can be used as an indicator to predict how severe these impacts might be. Research has shown that as the amount of impervious surface increases, the amount of runoff generated increases. This leads to increased amounts of water flowing in Spruce Creek, especially during heavy rainfalls; less ground water flowing through the soil; and more erosion of the stream bed because of faster flowing water. These changes may lead to flooding; habitat loss; erosion, which widens the stream channel; and physical changes in how the stream looks and functions. In Spruce Creek, **34% (64) of the NPS sites recorded imperious surfaces**. Roads and parking lots were the most common types of NPS found, yet other types of NPS recorded included driveways, boat ramps, docks, and building rooftops. Impervious surfaces contributes nutrients, sediment, bacteria, and toxics to the watershed.

- **Flow restrictions:** Flow restrictions may result from road crossings and inadequately sized, placed, or deteriorating culverts. They can also include places where erosion has added sediment buildup to the stream, places in which excess vegetation and trash have fallen and collected in the stream, and places where dams have been created. In general, flow restrictions can affect water quality by preventing aquatic organisms from freely traveling the stream and can cause water to pool. This can affect ecosystems and prevent nutrients from being naturally washed through the watershed and out to the ocean. Pooling water can also disrupt bank growth, which can cause an excess of nutrients to enter the water, and can greatly contribute to thermal pollution, allowing the water's temperature to increase dramatically. Flow restrictions due to logging/vegetative debris can add excess nutrients to the water and flow restrictions from deteriorating culverts can add rust, metals, and other toxic substances. Inadequate and inadequately placed culverts (hanging, misaligned, unstable, clogged) can change water flow speed, direction, and volume that can "blow out" crossings during big storms, erode banks, change natural stream channels and ecosystems, and prevent fish migration upstream. **Flow restrictions were recorded at just under 15% (29) of the sites.**

Other NPS pollution sources documented included (listed in decreasing occurrences): septic systems, ATV / recreational paths (many crossing through the stream), trail / foot paths, construction sites / construction site debris (old and new sites), pet / animal waste, possible pesticide / fertilizer use, storm drains, and pipe discharges. Parked cars near waterways, a diverted stream, a burnt site, a drainage ditch, a water intake site, a salt pile, and soil piles were also mentioned as NPS sites occurring in the watershed.

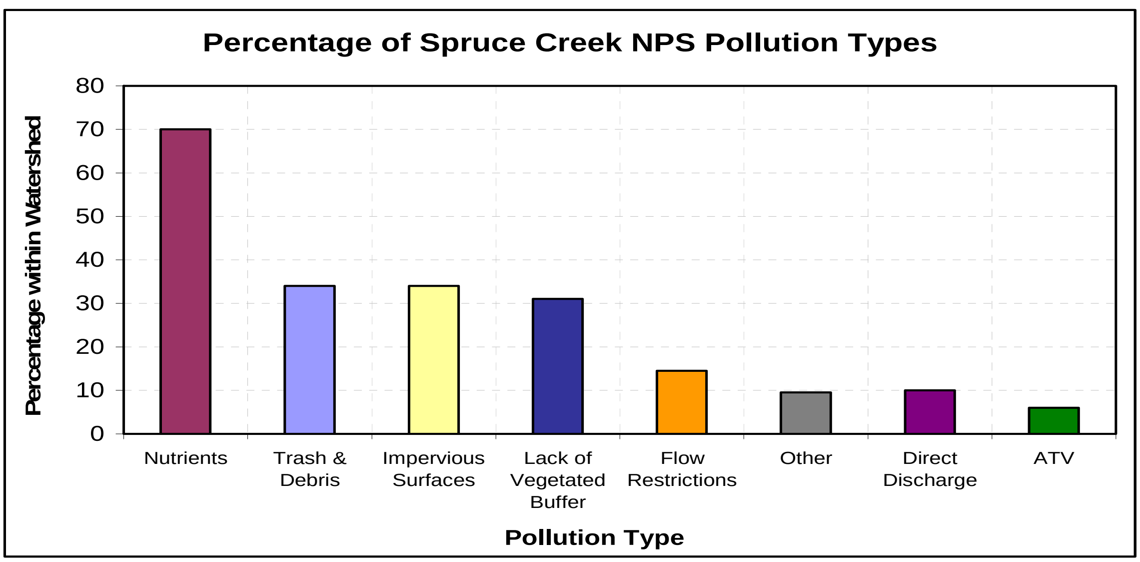
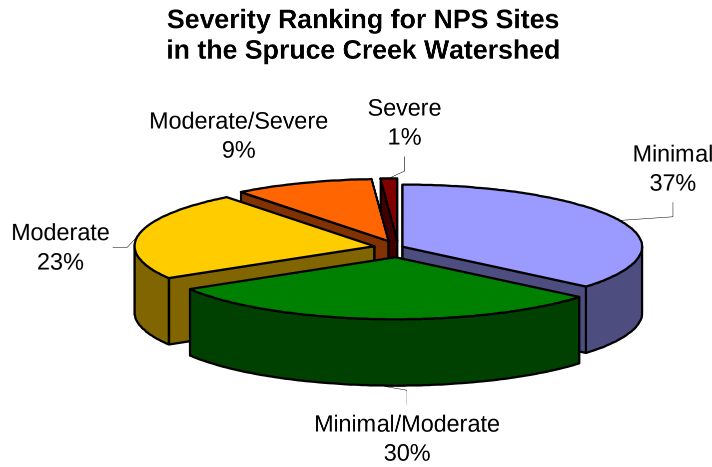


Figure 5.1.2. *Spruce Creek pollution types, by percentage of occurrence.*

NPS pollution sites in the Spruce Creek watershed were ranked based upon the expected impact they would have on surface water quality (Figure 5.1.2); volunteers rated the severity of each problem site as having a minimal, moderate, or severe impact on the watershed. A high number of sites were ranked minimal to minimal/moderate in severity compared to a relatively low number of moderate/severe to severe (11%). The high percentage of minimal impact sites suggests that a large number of sites will need to be addressed in order to improve water quality. In order to prioritize management and remediation of NPS sites in the watershed, sites should be ranked according to 1) severity; 2) technical skill level to required to install the BMPs; and 3) how much the BMPs would cost. A good management strategy should include remediating sites that are both high impact and high priority first.



# of Impacts	
Minimal	153
Minimal/Moderate	129
Moderate	98
Moderate/Severe	40
Severe	5

Figure 5.1.3. *Severity ranking of Spruce Creek NPS*

Stormwater Assessment and Retrofit Inventory of Route 1

In addition to the 2005 studies mentioned above, a Stormwater Assessment and Retrofit Inventory of U.S. Route 1 in Kittery was conducted by Hillier & Associates, Inc. in the fall and winter of 2004. The study was designed to identify and track the movement of storm run off from the many impervious road and parking lot surfaces along the one-mile commercial corridor of U.S. Route 1 and to identify potential best management practice stormwater retrofit locations. The stormwater assessment revealed **nine discrete subcatchment areas** that convey a combination of public and private stormwater runoff. The study also identified **21 stormwater outfall locations** as candidates for stormwater best management practice retrofit. The identified subcatchments conveyed a combination of public and private stormwater and contained high levels of suspended sediments. Stormwater samples also revealed high levels of bacteria loading and high levels of hydrocarbon loading from selected subcatchments. Through a Maine Department of Transportation (MDOT) Surface Water Quality Protection program (SWQPP) grant, work has been started at some sites identified in the 2005 inventory.

5.2 Point Sources

Unlike NPS pollution, point source pollution can be traced to a single identifiable source, such as overboard discharges (OBDs). As of 2007, there were **four known OBD sites** within the watershed. Two of these are licensed and on the Maine Departments of Environmental Protection's Priority for Removal list. The other two were previously undocumented until the summer of 2006.

> An **overboard discharge (OBD)** is the discharge of wastewater from residential, commercial, and publicly owned facilities to Maine's surface waters. If they are not properly maintained or if they malfunction, they have the potential to discharge the harmful bacteria and other pathogens directly into surface water.

> The **National Pollutant Discharge Elimination System (NPDES)** program regulates pollutants discharged directly into waterways from wastewater sources. Anyone discharging, or proposing to discharge, waste or wastewater into the surface waters of the State is required by law to obtain a NPDES permit.

Municipal and industrial point source stormwater discharges are addressed under the authority of the **National Pollutant Discharge Elimination System (NPDES).** The Stormwater Phase II Final Rule (1999) addresses stormwater discharges from small municipal separate storm sewer systems (MS4s) (those serving less than 100,000 persons). This rule requires operators of regulated small municipal separate storm sewer systems (MS4s) to obtain a National Pollutant Discharge Elimination System (NPDES) permit and develop a stormwater management program designed to prevent harmful pollutants from being washed by stormwater runoff into the MS4 (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies.

As part of this program, due to their proximity to Portsmouth, New Hampshire, the towns of Kittery and Eliot are required to develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable (Edwards and Kelcey 2005). The stormwater management program must include these six minimum control measures:

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

5.3 Other Potential Pollution Sources

Septic systems are another potential source of pollution to Spruce Creek. Most of the Spruce Creek Watershed is not served by municipal sewer. The exceptions are the southwest corner of the watershed (east of Remick Corners) and along U.S. Route 1 north of Ox Point Drive. Failing septic systems are a potential source of nutrients and bacteria. The fate and transport of nutrients from septic systems depends on several factors, including the age and type of system, distance from waterbody, number of people in the household, holding tank efficiency, soil type, and leach field porosity, among others (Castro et al., 2003). In Maine, systems put in place before 1975 have a much higher chance of malfunctioning than newer systems (Rocque 2005).

The Maine Department of Marine Resources (DMR) has conducted septic surveys in portions of the Spruce Creek watershed three times since 1996. The most recent survey, in October 0f 2005, was aimed at identifying potential sources of contamination of shellfish in the Goose Point area. Septic systems on the Haley Road side of Spruce Creek were surveyed and notes pertaining to the location and pumping frequency of each system, along with signs of potential system failure were recorded. Of the 29 properties inspected, two overboard discharges were discovered, but no failing septic systems were noted.

6. LINKING POLLUTANT SOURCES TO WATER QUALITY

6.1 Estimation of Pollutant Loads

Estimates of fecal coliform loads and sources in the Spruce Creek watershed were determined using the **Bacteria Source Load Calculator (BSLC)**, developed by the Center for TMDL and Watershed Studies. The BSLC is a spreadsheet model that characterizes how bacterial loads are spatially and temporally distributed by inventorying bacterial sources and estimating loads generated from these sources.

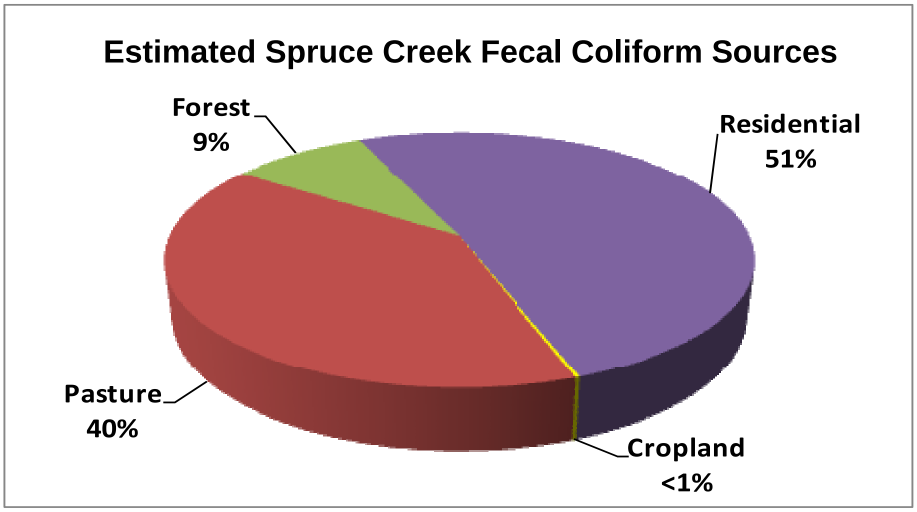
The BSLC incorporates user-generated, watershed-specific inputs, including land use distribution and livestock, wildlife, and human population estimates, to calculate monthly bacterial loadings (for Spruce Creek inputs, see **Appendix D**). Results are displayed by source (land use) in cfu's, or "colony forming units", per month and year. In the Spruce Creek watershed, yearly bacterial loads from all sources totaled just over 116,000 x 10^6 per year (Table 6.1.1). Land use data and additional model inputs gathered for the Spruce Creek watershed are as accurate as possible given all of the available information and resources utilized, final numbers for the land use analysis and bacteria loading numbers are approximate and should be viewed only as carefully researched estimations.

Table 6.1.1. (right) *Estimated monthly bacteria loads in the Spruce Creek watershed.*

Estimated Fecal Coliform Loadings (x10^{10} cfu/month)

Month	Cropland	Pasture	Forest	Residential
Jan.	13	4,108	1,194	5,034
Feb.	18	3,744	1,089	4,588
Mar.	44	4,271	841	5,034
Apr.	38	4,179	814	4,872
May.	19	4,318	841	5,034
Jun.	12	4,179	292	4,872
Jul.	13	4,318	302	5,034
Aug.	13	4,318	302	5,034
Sep.	12	4,179	1,156	4,872
Oct.	19	4,318	1,194	5,034
Nov.	22	4,133	1,156	4,872
Dec.	13	58	1,194	5,034
Total	234	46,123	10,375	59,314

Figure 6.1.2. (right) *Estimated human activities (including septic systems and pets) contribute the highest overall bacteria loadings in the Spruce Creek watershed.*



6.2 Identification of Critical Areas

To help prioritize and target management efforts within the Spruce Creek watershed, critical areas where the pollutant sources are causing the most damage have been identified. Spruce Creek watershed critical areas identified below are based on the highest priority and highest impact sites identified in the **Habitat Restoration Inventory**, the **319 NPS Pollution Survey**, and the **Stormwater Assessment and Retrofit Inventory of Route 1** conducted in 2005 (see pages 23-27). It is recommended that management measures be applied to these areas first.

Table 6.2.1. *Spruce Creek Habitat Restoration Critical Areas.*

Habitat Restoration Critical Areas[1]			
Site ID	Score	Restoration Type	Cost
SC-004	3.75	Buffer	Low
SC-001	3.1	Buffer, In-stream	Low
SC-024	1.8	Buffer	Low
SC-059	1.75	Buffer	Low
SC-071	1.75	Buffer	Low
SC-080	1.7	Buffer, Shoreline Bank	Low
SC-002	1.65	Buffer	Low
SC-032	1.65	Buffer	Low
SC-043	1.6	Buffer, Invasive Species Removal	Low
SC-019	1.5	Buffer, Invasive Species Removal	Low
SC-083	1.5	Buffer, Shoreline Bank	Low
SC-086	1.5	Buffer, Dock Improvement	Low
SC-030	1.3	Buffer, Dock Improvement	Low
SC-035	1.3	Buffer, In-stream	Low
SC-046	1.3	Buffer, Dock Improvement	Low
SC-061	1.3	Buffer	Low
SC-033	1.25	Buffer	Low
SC-007	1.2	Buffer	Low
SC-079	1.2	Buffer, Invasive Species Removal	Low
SC-003	1.15	Buffer	Low
SC-031	1.1	Buffer, Dock Improvement	Low
SC-042	1.1	Buffer, Dock Improvement	Low
SC-065	1.05	Buffer	Low
SC-066	1.05	Buffer	Low
SC-016	1	Dock Improvement	Low
SC-020	1	Buffer, Dock Improvement	Low
SC-057	1	Buffer, Shoreline Bank	Low
SC-058	1	Buffer, Shoreline Bank	Low

[1]*Habitat Restoration Critical Areas are those sites identified in the 2005* ***Habitat Restoration Inventory*** *as having the highest impact (scores >1), combined with the lowest remediation costs.*

Table 6.2.2. *Spruce Creek NPS Pollution Critical Areas.*

NPS Pollution Critical Areas[2]			
Site ID	**Site Type**	**Possible Types of Pollutants**	**Severity of Site**
1_2	Residential	nutrients	moderate/severe
11_16	Residential	bacteria, nutrients, excess or contaminated sediment	moderate/severe
12_10	Commercial, Residential	bacteria, nutrients, increased water temperature	moderate/severe
12_15	Commercial, Road	increased water temperature	moderate/severe
12_4	Commercial, Rt. 1	nutrients, increased water temperature	moderate/severe
12_9	Commercial, Parking Lot	excess or contaminated sediment, increased water temperature	moderate/severe
13_8c	Road (Route 1)	toxic, bacteria, nutrients, excess or contaminated sediment, increased water temperature, keeping the tide from flushing the upper creek	moderate/severe
13_8d	Road (I-95)	toxic, nutrients, excess or contaminated sediment, increased water temperature	moderate/severe
2_15	Residential	bacteria, nutrients	moderate/severe
3_7	Residential, Road (Wilson Rd)	Excess or contaminated sediment. Increased water temperature	moderate/severe
3_8	Residential	Nutrients, excess or contaminated sediment	moderate/severe
6_6	Commercial	toxic, nutrients, increased water temperature?, suspected low dissolved oxygen	moderate/severe
6_7	Commercial	toxic, nutrients, increased water temperature?, suspected low dissolved oxygen	moderate/severe
7_16	Road		moderate/severe
11_12	Residential	nutrients, excess or contaminated sediment	severe
12_5	Commercial	nutrients, excess or contaminated sediment, increased water temperature	severe
14_31	Residential		severe
12_7	Residential, Road (Martin Rd)	nutrients, excess or contaminated sediment, increased water temperature, suspected low DO	severe

[2]*NPS Pollution Critical Areas are those sites identified in the 2005* ***NPS Pollution Survey*** *as having the highest impact (moderate/severe and severe ratings). In order to further prioritize critical NPS sites in the watershed, it is recommended that the sites listed here be ranked according to remediation costs and technical level.*

Table 6.2.3. *Spruce Creek Stormwater Retrofit Critical Areas.*

Subcatchments	Stormwater Retrofit Critical Areas[3] Comments
4, 8	**Subcatchments 4 and 8 have the highest level of stormwater impacts to Spruce Creek** during equivalent storm events and generate 67% of the total TSS pollutant load from all 9 subcatchment areas.
	Property #47_01, which comprises **the majority of Subcatchment 4 could be relatively easily retrofitted** with bioretention swales in the locations of existing raised parking dividers.
1,2,5	**Subcatchments 1, 2, and 5 have the highest load per unit area** and may provide effective stormwater treatment from a cost-benefit analysis.
	Subcatchments 1 and 2 should be considered for further retrofit evaluation based on numerous retrofit opportunities within the subcatchment areas and high unit area loading.

*[3]Stormwater Retrofit Critical Areas are those subcatchments identified in the 2005 **Stormwater Assessment and Retrofit Inventory of Route 1** as having the highest overall level of stormwater impact (subcatchments 4 & 8) or the highest stormwater load per unit area (subcatchments 1,2 & 5).*

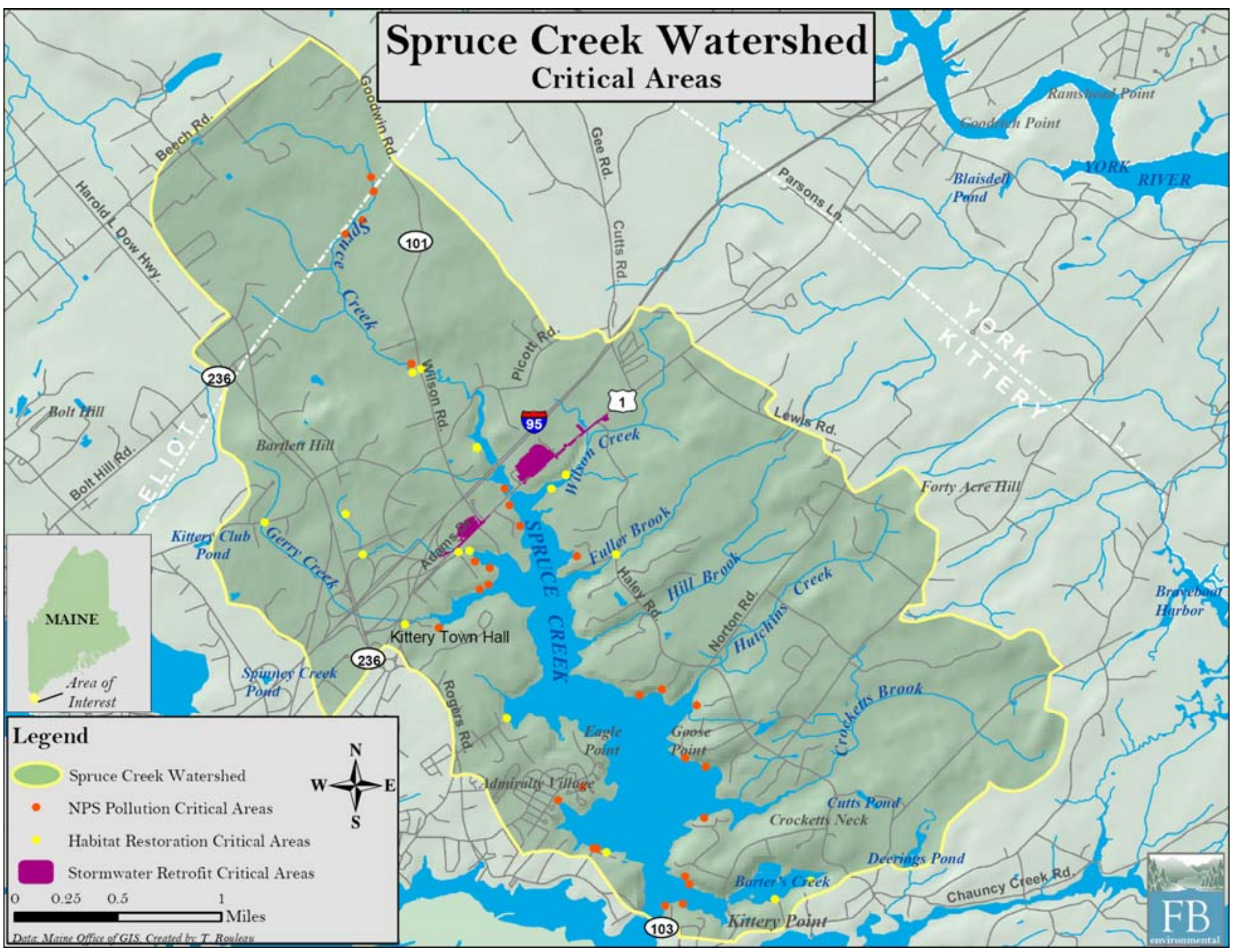


Figure 6.2.1. *Map of Spruce Creek Critical Areas (see **Appendix B** for larger map).*

7. Watershed Goals and Objectives

7.1 Management Objectives

Objectives of the management plan are focused on improving water quality in Spruce Creek for the benefit of fish, birds, and other wildlife, as well as local residents, landowners, and visitors. The following objectives were established by stakeholders at the 2006 Spruce Creek Community Forum:

1. **Reduce bacterial loads (open shellfish beds).**
   a. Continue and enhance water and shellfish sampling
   b. Curb bacterial loading
   c. Identify and repair failing septic systems
   d. Identify OBDs
   e. Identify homes not connected to sewer system (legally and illegally) and encourage them to connect

2. **Protect and restore vegetated buffers.**
   a. Inform citizens and businesses about shoreland zoning rules
   b. Enforce shoreland zoning
   c. Incentivize maintaining, restoring, and expanding riparian buffers
   d. Restore a structurally diverse vegetated buffer throughout the watershed
   e. Educate the public and adjacent landowner of the value of maintaining vegetated buffers
   f. Establish Youth Conservation Corps projects
   g. Restore/protect eel grass
   h. Encourage voluntary permanent protection of shoreland buffers through easements

3. **Stop trash and debris dumping, including yard waste, and clean up current sites**.
   a. Clean up sites
   b. Change regulations and code to enable enforcement
   c. Educate landowners

4. **Limit impervious surfaces and minimize their impacts.**
   a. Encourage innovations in new construction
   b. Retrofit existing sites whenever possible
   c. Encourage naturalized landscaping
   d. Reduce/eliminate chemical inputs

5. **Improve stream crossings and reduce flow restrictions.**
   a. Learn more about impacts and better engineering
   b. Reduce restrictions (replace culverts, etc.)
   c. Reduce erosion, silting, and obstructions
   d. Improve road crossings by planting additional low-growing shrubs
   e. Improve fish passage

6. **Increase amount of conservation land.**
    a. Work on open space plan for the whole watershed
    b. Work with Open Space Committee and local land trusts

7. **Continue assessments and evaluations.**
    a. Gather existing data, assessments & studies
    b. Establish water quality trends
    c. Continue the search for sources of pollution
    d. Conduct fish survey
    e. Conduct analysis of soils and sediments
    f. Quantify current silt loads at crossings
    g. Conduct analysis of fecal population and sources (especially in agricultural areas)
    h. Explore purchase of data sondes & webcams for continual water quality monitoring

8. **Reduce ATV/ORV impacts on water quality.**
    a. Enforce ATV laws
    b. Restore sites damaged by ATV/ORV use
    c. Provide education information to riders and landowners
    d. Encourage the formation of ATV clubs for responsible riding
    e. Interact with ATV dealers

9. **Control and treat stormwater from commercial areas.**
    a. Reduce or eliminate private sources of water to the public stormwater drainage network when opportunities exist
    b. Develop a comprehensive stormwater mitigation plan
    c. Explore source area controls on private property and selected “upstream” disconnections
    d. Establish and manage traded “pollutant credits” to incentivize use of new technologies to control and treat stormwater on private lands
    e. Pursue funds through MDEP 319 program to assist private landowners with pollution treatment strategies
    f. Use publicly owned land for stormwater improvement location
    g. Encourage more curb break sites
    h. Better understand maintenance of public and private catch basin and stormwater treatment systems and encourage stormwater retrofits as maintenance activity
    i. Establish pet walking zones for shoppers within the commercial district
    j. Consider other retrofit opportunities within the subcatchment areas, including bioretention swales in the locations of existing raised parking dividers, modifications to the existing “detention basin”, etc.
    k. Identify available resources for stormwater retrofit funding
    l. Increase exposure of the extensive influence of stormwater on the lower Spruce Creek watershed through public education

10. **Address docks/piers/jetties issues.**
    a. Coordinate town regulations with state and federal standards
    b. Work with boaters and home owners to understand impacts of docks and piers and their maintenance

11. **Control invasive species.**
    a. Work with Rachel Carson National Wildlife Refuge (RCNWR), and other resources, on biocontrol sites
    b. Coordinate efforts with volunteers and town officials on removal of species

12. **Develop and implement outreach programs.**
    a. Develop Shoreland Zoning brochure/materials
    b. Work with residents on improved farming practices
    c. Explore developing a demonstration LID site at malls
    d. Consider creating a watershed information center
    e. Signs at watershed boundary
    f. Boater Education
    g. Gardening events
    h. Archaeological interest
    i. Realtor education and disclosure program
    j. Homeowner land practices (implement a program such as Yardscaping)
    k. Integrate watershed and water quality topics into K-12 programs (including state curriculum and storm drain stenciling)

13. **Improve land use ordinances, design standards and evaluate comprehensive plan to incorporate citizen concerns for water quality and watershed issues.**
    a. Minimize water quality impacts of land conversion from rural to more developed uses
    b. Stormwater ordinances
    c. Evaluate and strengthen septic ordinances (mandatory pumpout, system inspections, joint purchase of pumpouts, GIS layers, get more folks connected to sewer)
    d. Develop LID guidance
    e. Enhance building permit requirements related to water quality
    f. Evaluate implementation of Comp Plan: Shoreland Overlay Zone, Conservation of Kittery Wetlands, and Resource Protection District
    g. Work closely with Planning Board
    h. Create a business certification ("creek friendly") program

14. **Implement Builder and Landscaper certification program.**
    a. Include mandatory participation in workshop and incentive elements

15. **Supplement Town GIS layers.**
    a. Create a database of watershed issues and fixes

7.2 Load Reduction Targets

When enough data are available, reductions in the concentration bacterial TMDL or loading capacity necessary to meet water quality standards can be calculated to obtain a rough estimation of pollution abatement action needed. For Spruce Creek, the estimate of percent reduction needed was calculated based on the difference between measured fecal coliform data from the years 2004 through 2007 and the water quality criteria for approved shellfish growing areas (geometric mean shall not exceed 14/100mL and estimated 90th percentile shall not exceed 31/100mL (Maine DMR (2007)). Water quality criteria were compared to both the geometric mean and the highest concentration level measured at each of the seven monitoring sites.

To calculate the estimated % reduction necessary to achieve the fecal coliform water quality standard in Spruce Creek:

Percent fecal coliform reduction = ((Fecal coliform measured value – Fecal coliform standard) /Fecal coliform measured value) x 100

(calculation based on the draft MDEP methodology for developing bacteria TMDLs)

Results show the overall reduction target to be 93%, based on the highest measured concentrations at all sites. Site WA028 (below the U.S. Route 1 overpass) has the highest reduction targets at 93% based on highest measured concentrations and 77% based on geometric means.

Table 7.2.1. *Spruce Creek Fecal Coliform Reduction Targets.*

Site[1]	Fecal coliform maximum measure	Fecal coliform geometric mean	% Reduction (Max)[2]	% Reduction (Geomean)[2]
WA024	43	12	28%	0%
WA028	460	62	93%	77%
WA029	460	46	93%	70%
WA030[3]	240	61	87%	77%
WA031	180	30	83%	53%
WA033	460	42	93%	67%
WA034	27	7	0%	0%
WA035[3]	23	9	0%	0%
WA036	93	10	67%	0%
All Sites	**460**	**8**	93%	0%

[1] *For map of site locations, see Map 10, Appendix B.*

[2] *For all maximum measures, % reduction was calculated using 90th percentile (P90) standard (31 fecal coliforms/100 mL); For all geometric means, % reduction was calculated using geomean standard (14 fecal coliforms/100 mL).*

[3] *Analysis for sites WA030 and WA035 based on 2004-2005 data only.*

Spruce Creek at I-95 overpass.
(Photo: Rachel Bell, 2007)

8. MANAGEMENT STRATEGIES

8.1 Existing Management Strategies

For nearly 20 years, the towns of Kittery and Eliot and the primary watershed stakeholders have been effectively working to better understand the types and sources of pollution in the Spruce creek watershed. Table 8.1.1 summarizes water quality accomplishments and activities in the watershed to date.

Table 8.1.1. *Water Quality Accomplishments in the Spruce Creek watershed.*

Spruce Creek Watershed Accomplishments to date

Date	Accomplishment
1989	Moulton Easement: conservation easement on 12 acres of woods and farmland on Haley Rd. (KLT)
1991	Thompson Easement: conservation easement on 18 along Spruce Creek (KLT)
1993-2007	Coastal Cleanup (Kittery, SCA)
1993	Expansion of Coastal Cleanup to include points on Spruce Creek - notably Eagle Point & Rogers Park (KCC)
1997	The Spruce Creek Project: Nonpoint Source Pollution Curriculum for the Frisbee Middle School (KCC)
1998	Estuary Day: KCC members handed out copies of the Spruce Creek Project and information about coastal estruaries, watersheds, and NPS pollution at various locations in the Spruce Creek watershed
1989-2007	Fecal Coliform Monitoring (DMR, KSCC, SCA)
1999	KLT aquired 22 acres off Haley Rd., known as the Cutts Property (KLT)
1999	Tennessee teens tackle trash: 27 teens and chaperones from the College Street Church of Christ in Lebanon, TN cleaned up trash at Eagle Point (KCC, Kittery Public Works)
2002	Kittery Adopted Comprehensive Plan (March 25, 2002)
2004	KLT aquired 28 acres off Brave Boat Harbor Rd.., known as the Furbish Property (KLT)
2004	Stormwater Assessment and Retrofit Inventory of U.S. Route 1 (MSPO)
2004	SCA Annual Meeting & "What is a Watershed?" Presentation (SCA)
2005	Removal Assessment Tidal Restriction at U.S. Route 1 (Kittery)
2005	Inventory of Habitat restoration Opportunities (Maine State Planning Office)
2005	Healthy Beaches Enterococcus Monitoring (SCA, Maine Healthy Beaches)
2005	MS4 Watershed Survey Report (Kittery)
2005	SCA Annual Meeting & "Buffers and the Use of Native Plants" Presentation (SCA)
2005-2008	Installation of LID stormwater mitigation measures along U.S. Rte. 1 near Factory Outlets (Kittery, MDOT)
2005-2006	Nonpoint Source Pollution Survey (Kittery, Eliot, SCA)
2005, 2007	Storm Drain Stenciling (Kittery, Eliot, SCA)
2005-2007	Water Quality Monitoring (SCA)
2006	Kittery Practice Field BMP Design (Kittery Public Works, UNH Stormwater Center)
2006	SCA Annual Meeting & "Environmental History of Spruce Creek" Presentation (SCA)
2007	Purple Loosestrife Beetle Release Program (SCA, Rachel Carson NWR)
2007-2008	Culvert Assessment and Replacement at Picot and Wilson Rodas (Kittery)
2007	Coastal Connections: Coastal Watershed Unit aligned with the State of Maine Learning Results (SCA Steering Committee, Shapleigh Middle School, Kittery, Mark Gunter, Maine Sea Grant Extention)
2007-2008	Thompson Mill Pond Restoration Opportunity Assessment (Kittery Land Trust, SCA)
2008	Kittery Practice Field BMP Construction (Kittery Public Works, UNH Stormwater Center)

8.2 Additional Strategies Needed to Achieve Goals

NPS Management Strategies

Stormwater runoff is one of the largest water quality concerns in Spruce Creek. There are two primary problems associated with stormwater runoff: the increased volume and rate of runoff from impervious surfaces, and the concentration of pollutants in the runoff. Both components, which are directly related to development, cause changes in hydrology and water quality that result in a variety of problems, including habitat modification and loss, increased flooding, decreased aquatic biological diversity, and increased sedimentation and erosion. Effective management of stormwater runoff offers many possible benefits, including protection of wetlands and aquatic ecosystems, improved quality of receiving waterbodies, conservation of water resources, protection of public health, and flood control.

BMPs are any structural or non-structural practice to treat, prevent or reduce water pollution. These practices can be as simple as revegetating bare soil and planting shrubs along the water front, or more involved such as installing sediment detention basins to capture and filter sediments before they enter the water course. Often, a variety of BMPs may be needed to adequately treat NPS pollution. The following list provides examples of many different BMPs that can be applied to NPS problems identified in the watershed the Spruce Creek watershed:

Erosion on Roads and Driveways

- *Add new surface material* to stabilize roadways
- *Install runoff diverters* (broad-based dip, rubber razor, waterbar)
- *Install ditch turnouts or diversion channels* to send overland flows to stable areas
- *Use detention basins* at ditch turnouts to retain water between runoff events, and remove suspended sediments and adsorbed pollutants
- *Remove grader berms*
- *Remove excess winter sand*
- *Reshape/vegetate road shoulder*
- *Reshape or crown* roads to reduce water on surface
- *Pave dirt roads*
- *Install permeable pavement* to allow water infiltration in high traffic areas

Inadequate Vegetated Buffer and Bare Eroding Soil

- *Establish buffers* to reduce direct flow to waterbody
- *Extend buffers* to a minimum of 75’ on all streams
- *Plant trees, shrubs and ground covers* to stabilize soil and reduce runoff
- *Reduce* lawn areas
- *Seed bare soil with grass* to provide temporary or permanent cover

Example of inadequate riparian buffer along Spruce Creek. (Photo: Rachel Bell).

- *Mulch bare soil* with straw, wood fiber, or chips, etc. over a seeded area to protect the bed from erosion and drying
- *Use sod transplants* to stabilize erosion prone areas

Poorly Functioning Culverts

- *Clean out culverts regularly* to minimize blockage and backflow
- *Enlarge, replace, or lengthen culverts* to account for type of flow
- *Install plunge pools* to reduce downstream erosion
- *Stabilize inlets/outlets* with rock and vegetation to reduce erosion

Inadequate Ditches

- *Install new ditches* to capture runoff from roads
- *Armor ditches with stone* to stabilize ditch and minimize erosion by runoff water
- *Stabilize ditches* with a grass to allow for concentrated flow without erosion
- *Reshape ditches* to minimize pitch and maximize storage
- *Install turnouts* to convey water to reduce flow to waterbody
- *Install check dams* to reduce erosive flows in drainage ditches/allow revegetation

Direct Flow from Roof Runoff

- *Install a stone-filled dripline trench* to capture and infiltrate rainwater
- *Install a drywell* at gutter down spout to capture water and prevent overland flow
- *Install rain barrels and/or rain gardens* to collect and filter rainwater

Unstable Shoreline/Beach Access

- *Revegetate or terrace* steep eroding slopes
- *Establish a defined path* for foot traffic
- *Install steps* to reduce erosion on steep foot paths
- *Design winding paths* to waterfront instead of straight paths
- *Minimize path widths* (must be less than 6')

Stormwater Runoff in Urbanized Areas

- *Use oil/grit separators* to remove coarse sediment and oils in stormwater
- *Install sumps on catch basins* to capture solids before they enter the sewer system
- *Create sediment detention basins* to receive, detain and reduce sediments in stormwater from heavily impervious areas
- *Use flow control devices* to release water at non-erosive flow rate
- *Install infiltration basins* to impound water over permeable soils and allow controlled infiltration and removal of fine sediments and adsorbed pollutants

Construction Site Erosion Controls

- *Put up fences and signs* to contain damage caused by heavy equipment
- *Use grading plans* to minimize erosion
- *Use filter strips and buffers* to prevent runoff, and stabilize erosion prone slopes.
- *Place soil piles* where they will not erode into watercourse
- *Seed and install effective erosion barriers* (temporary BMPs) around spoil piles
- *Stage projects* to minimize area of exposed soil at any one time
- *Select and protect trees* to the maximum extent possible, prior to construction.
- *Dewater* with well points/ cofferdams and pumps to remove ground and surface water from a construction site to reduce scarring and erosion
- *Install filters* of crushed stone, straw or geotextile to remove sediment from stormwater before it exits a construction site

Other

- *Install watercourse crossings* to confine erosional impacts and minimize flow alterations at points of crossing
- *Practice good fertilizer management techniques* to minimize nutrient inputs to the water course

Point Source Management Strategies

Illicit Discharge Detection and Elimination

- Phase II MS4s are required to develop a program to detect and eliminate these illicit discharges. This primarily includes developing:
  - ⇒ a storm sewer system map,
  - ⇒ an ordinance prohibiting illicit discharges,
  - ⇒ a plan to detect and address these illicit discharges, and
  - ⇒ an education program on the hazards associated with illicit discharges.
- Audit existing resources and programs
- Establish responsibility, authority, and tracking
- Complete a desktop assessment of illicit discharge potential

8.3 Load Reduction Estimates

The management guidance provided above is intended to support evaluation of BMP alternatives and identification of next steps in the process of mitigating water quality impairment in Spruce Creek. It is difficult to predict in detail the pollutant loading reduction that may be achieved using a management practice or BMP. Additional site-specific evaluation will be required to support precise quantification of the nature and extent of pollutant reductions that would be achieved through implementation of the mitigation measures described above. Table 8.3.1 provides estimates of pollutant removal efficiencies for various types of practices and BMPs. These estimates are the result of investigations conducted throughout the United States and were compiled by the U.S. Environmental Protection Agency. These removal efficiency values are useful to support planning and selection of appropriate mitigation measures, but should be considered rough estimates of actual removal performance. Factors that can affect the reporting of BMP performance include:

- Number of storms sampled
- Manner in which pollutant removal efficiency is computed
- Monitoring technique employed
- Sediment/water column interactions
- Soil type
- Rainfall, flow rate, and particle sizes of the influent
- Size and land use of the contributing catchment
- Incoming pollutant concentrations

Table 8.3.1. *Structural BMP Expected Pollutant Removal Efficiency.*

BMP Type	Typical Pollutant Removal (percent				
	Suspended Solids	Nitrogen	Phosphorous	Pathogens	Metals
Dry Detention Basins	30 – 65	15 – 45	15 – 45	< 30	15 – 45
Retention Basins	50 – 80	30 – 65	30 – 65	< 30	50 – 80
Constructed Wetlands	50 – 80	< 30	15 – 45	< 30	50 – 80
Infiltration Basins	50 – 80	50 – 80	50 – 80	65 – 100	50 – 80
Infiltration Trenches/Dry Wells	50 – 80	50 – 80	15 – 45	65 – 100	50 – 80
Porous Pavement	65 – 100	65 – 100	30 – 65	65 – 100	65 – 100
Grassed Swales	30 – 65	15 – 45	15 – 45	< 30	15 – 45
Vegetated Filter Strips	50 – 80	50 – 80	50 - 80	< 30	30 - 65
Surface Sand Filters	50 – 80	< 30	50 – 80	< 30	50 – 80
Other Media Filters	65 – 100	15 – 45	< 30	< 30	50 – 80

Source: US EPA 1993

9. Plan Implementation

9.1 Plan Oversight

The Spruce Creek WBMP Steering Committee, along with the towns of Kittery and Eliot, will need to continue to meet regularly and be diligent in coordinating resources to implement practices that will reduce NPS pollution in the Spruce Creek watershed. This task cannot be accomplished alone, and will require the support of a number of watershed groups including the SCA, Kittery Land Trust, York County Soil and Water Conservation District, Maine DEP, schools, and individual landowners.

> The towns of Kittery and Eliot will take the lead on ensuring that the action items in this plan are initiated. This plan is a product of watershed stakeholders from SCA, local land trusts, nonprofits, municipal and state government, and the community. As such, the responsible party for each action item may be the watershed towns or any one of these partnering stakeholders.

The formation of smaller action committees will result in more efficient plan implementation. Suggested action committees are as follows:

- **Buffer/Invasives and Conservation Lands**
- **Water Quality Assessment**
- **Stormwater/Impervious Cover and Bacteria Reduction**
- **Fundraising/Grantwriting (includes two members of each of subcommittees 1-3)**

These action committees would be charged to implement projects and actions with agency and watershed organization support.

9.2 Action Plan

The SCA Steering Committee will work toward improving and implementing an Action Plan which consists of action items within five major categories: Buffers and Invasives, Bacteria Reduction, Impervious Cover and Stormwater, Conservation Lands, and Water Quality Assessment (Table 9.2.1). This Action Plan was developed to follow-up on objectives developed in the 2005 watershed survey, and from feedback received by 30 community members at the 2006 Spruce Creek Watershed Community Forum. Forum participants (local town officials, watershed landowners, and SCA members) formed small groups to discuss critical watershed issues related to water quality, wildlife habitat, recreation, and land development issues that need to be addressed in the watershed. Participants then prioritized potential watershed objectives. These ideas have been incorporated into the Action Plan. This Action Plan outlines responsible parties, potential funding sources, approximate costs, and an implementation schedule for each task within each of the five categories.

Buffers and Invasives

The buffer action items place a strong emphasis on improving protection of shoreland vegetated buffers, to meet or exceed the existing state guidelines requiring that no more than 40% of existing woody vegetation in the 250 foot wide shoreland zone is removed. Action items include encouraging stewardship through buffer planting demonstrations and encouraging strict enforcement of Riparian Zoning Laws. Additionally, watershed towns will coordinate with local land trusts in acquiring land within riparian zones. In order to reduce invasive plant species, action items in this category also include the removal of invasive species in high priority areas and encouraging the use of native species and beneficial habitat types. Additional actions include installing signs at the watershed boundary, holding Creek clean-up days, and enforcing ATV laws.

Bacteria Reduction

The bacteria reduction component of the Action Plan focuses on reducing the effects of septic systems on Spruce Creek through educating citizens and identifying problem sites. Actions also include working with watershed residents to reduce the impacts of livestock and pets.

Impervious Cover and Stormwater

The Action Plan focuses on reducing the impacts of impervious cover and stormwater through the education of residents, developers, and business owners. Actions include encouraging residential stormwater practices and awarding businesses using IC reduction practices, as well as holding informational seminars for developers.

Conservation Lands

The conservation lands component of the Action Plan requires continued cooperation between watershed towns, local land trusts, and project stakeholders to strategize land protection on a watershed level and develop an open-space plan for the watershed. Tasks include encouraging "green infrastructure" at the municipal level and looking into allowing greater public access to open space. Additionally, the watershed towns will coordinate with local land trusts in acquiring land within riparian zones.

Water Quality Assessment

While SCA has a strong water quality monitoring component, additional action is required to monitor the health of Spruce Creek on a long-term basis. This requires seeking funding to increase efficiency and obtain additional equipment such as continuous data loggers (datasondes). Additional stormwater sampling in the spring and fall may include both high/low tide and wet/dry monitoring. To better prioritize monitoring efforts and monitor plan effectiveness, it is also important to continuously link management strategies to measurable results. Results would be displayed on the Town of Kittery website as well as the websites of other stakeholders where appropriate. Additional actions include creating photo documentation of baseline shoreland conditions, researching the effects of the Portsmouth Naval Shipyard and the Piscataqua River on Spruce Creek, and establishing a chemical spill assessment program.

Funding

In order to successfully implement the above actions, it is necessary to continuously seek out funding sources. Potential funding sources are listed in **Section 9.4**.

Table 9.2.1. *Spruce Creek Action Items*

Action Items	Priority	Responsible Party: SCA	Responsible Party: YCSWCD	Responsible Party: Land Trusts	Responsible Party: Towns	Responsible Party: Schools	Responsible Party: Landowners	Funding Source: Maine DEP 319	Funding Source: Other Federal	Funding Source: Other State	Funding Source: Towns	Funding Source: Private	Funding Source: Volunteer	Costs (Approx.)	Schedule
BUFFERS & INVASIVES															
Encourage stewardship through buffer planting educational demonstrations. Hold volunteer work parties to install BMP demos at high profile sites. Hold neighborhood meetings to educate landowners about shoreland buffers.	H	x	x			x	x				x	x	x	$10,000/yr	Summer 2008 and ongoing
Encourage stricter enforcement of riparian zoning laws, utilizing alternative penalties such as replantings and mandatory community service in lieu of fines.	M	x			x			x					x	N/A	Immediately and ongoing
Develop an incentive program for voluntary buffer increases.	M	x			x		x	x			x		x	$2,000/yr	2008 and ongoing
Work with local nurseries to get plan discounts and donated time for buffer plantings.	M	x					x						x	N/A	Summer 2008 and ongoing
Install watershed signs along road to delineate watershed boundary (example: "You are entering the Spruce Creek Watershed").	M	x	x		x			x			x		x	$500/yr	2008 and ongoing
Develop informational materials to educate citizens and businesses about new shoreland zoning rules.	M	x	x		x						x	x	x	$500/yr	2009
Promote beneficial habitat types and the use of native species and discourage non-beneficial habitat types.	M	x	x		x		x	x			x		x	$500/yr	2008 and ongoing
Utilize resources such as TV, newspaper, SCA website, and public meetings for watershed education.	H	x				x	x				x	x	x	$500/yr	Immediately and ongoing
Coordinate efforts with volunteers and town officials on removal of invasive species, beginning with high priority sites from 2005 Habitat Survey.	M	x	x				x				x	x	x	$10,000/yr	2008 and ongoing
Coordinate Creek clean-up days to remove trash and educate citizens.	M	x	x		x	x		x			x	x	x	$500/yr	Annually, beginning 2008
Enforce ATV laws.	M	x		x	x		x						x	$2,000/yr	Beginning 2008

Table 9.2.1. *Spruce Creek Action Items*

Action Items		Responsible Party						Funding Source						Costs (Approx.)	Schedule
	Priority	SCA	YCSWCD	Land Trusts	Towns	Schools	Landowners	Maine DEP 319	Other Federal	Other State	Towns	Private	Volunteer		
BACTERIA REDUCTION															
Hold "septic socials" to inform residents about the relationship between septic systems and water quality.	H	x	x		x		x	x			x	x	x	$5,000/yr.	Beginning 2008
Establish a septic system tracking program; identify homes not connected to the sewer system; identify failing septic systems.	H	x			x		x	x		x	x		x	$20,000	Beginning 2008
Assess potential impacts of agriculture in the watershed by surveying the locations and numbers of livestock and horses. Work with farmers on improved animal management practices.	H	x	x				x				x		x	$5,000	Beginning 2008
Prioritize sites for tidal restriction removal.	M	x			x				x	x	x		x	$25,000/yr.	Beginning 2008
Promote pet waste management (example: establish pet walking zones for shoppers within the commercial district).	H	x			x		x				x	x	x	$2,000/yr.	Immediately and ongoing
IMPERVIOUS COVER & STORMWATER															
Encourage residential stormwater prevention practices (e.g. rain gardens/barrels) and educate homeowners about lawn alternatives.	H	x	x		x			x		x	x	x	x	$3,000/yr.	Immediately and ongoing
Conduct Public outreach and encourage more business involvement.	H	x					x	x			x	x	x	5,000/yr.	Beginning 2008
Develop a comprehensive stormwater mitigation plan.	H	x	x		x		x	x	x	x	x	x	x	$75,000	Beginning 2008
Create additional developer incentives.	H	x				x	x				x		x	$2,000/yr	Beginning Summer 2008 and ongoing
Coordinate with Town Planning Departments to hold pre-development/permitting seminars for developers.	M	x			x						x		x	$5,000/yr	Beginning 2009
Recognize / award businesses using IC reduction practices	M	x			x					x	x			$1,000/yr	Beginning 2008
Inventory % lawn area in the watershed to determine the overall IC impacts.	M	x	x		x						x		x	$5,000	2009
Create cost estimates for existing stormwater retrofit plan.	M	x	x		x			x	x	x	x			$50,000	Beginning 2008
Conduct ordinance review to determine if requirements provide adequate protections.	M	x				x	x					x	x	$1,000	Beginning 2008
Visit UNH Stormwater Center to learn about BMPs.	H	x					x						x	N/A	Immediately
Identify available resources for stormwater retrofit funding	M	x	x		x			x		x	x			$2,000	Beginning 2008
Continue working with MDOT's SWQPP program.	M				x									N/A	Ongoing

Table 9.2.1. *Spruce Creek Action Items*

Action Items	Priority	Responsible Party						Funding Source						Costs (Approx.)	Schedule
		SCA	YCSWCD	Land Trusts	Towns	Schools	Landowners	Maine DEP 319	Other Federal	Other State	Towns	Private	Volunteer		
CONSERVATION LANDS															
Coordinate with local land trusts to acquire land to protect riparian areas	H		x	x	x		x			x	x	x	x	N/A	Beginning 2008
Work with open space committee and land trusts to strategize protection of watershed open space and develop a watershed-based open space plan.	H	x		x	x		x				x		x	$15,000	Beginning 2008
Encourage "green infrastructure" to reduce municipal costs.	H	x	x	x	x								x	N/A	Summer 2007 and ongoing
Look into allowing greater public access to watershed open spaces (and consider the potential negative effects of doing so).	M	x		x	x		x			x	x		x	$500	Beginning 2008
Use conservation or open space subdivisions to reduce numbers of lots in shoreland zone.	M	x		x	x		x				x		x	N/A	Beginning 2008
WATER QUALITY ASSESSMENT															
Conduct stormwater monitoring program (e.g., wet-dry / hi-lo tide bacteria sampling).	H	x	x					x	x		x		x	$20,000/yr	Beginning spring 2008
Conduct baseline sediment study (including benthic communities).	H		x		x					x			x	$20,000	2008-2009
Link management strategies to measurable results and provide periodic updates on SCA website.	H	x			x		x	x					x	N/A	Immediately and ongoing
Create photo documentation of baseline shoreland conditions.	H	x	x		x		x				x		x	$500/yr	Immediately and ongoing
Research impact of Navy yard and Piscataqua on Spruce Creek and look into the need for related sampling.	M	x			x				x	x			x	$25,000	Beginning 2008
Explore funding options to increase volunteer efficiency and purchase new monitoring equipment (e.g. datasondes and webcam).	H	x			x		x			x	x		x	$30,000	Immeditaly and ongoing
Create watershed database for use with Town GIS data layers.	H	x			x							x	x	N/A	Beginning 2008
Establish chemical spill assessment program.	M	x			x				x	x	x		x	$10,000	2009

9.3 Indicators to Measure Progress

Establishing indicators to measure progress provides short-term input on how successful the WBMP has been in meeting the established goals and objectives for the watershed. It provides for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant on an ongoing basis. In addition to water quality monitoring the following environmental, social, and programmatic indicators will be used to measure the progress of the Spruce Creek WBMP:

- **Programmatic indicators** are indirect measures of watershed protection and restoration activities. Rather than indicating that water quality reductions are being met, these programmatic indicators will indicate actions intended to meet the water quality goal.
  - ⇒ Number of BMPs installed.
  - ⇒ Amount of funding secured for plan implementation.
  - ⇒ Number of acres of preserved open space.
  - ⇒ Number of direct discharges removed from the watershed.
  - ⇒ Number of stream cleanups conducted.
  - ⇒ Number of septic socials held.
  - ⇒ Number of flow restrictions removed.
  - ⇒ Feet of shore line permanently protected.

- **Social Indicators** measure changes in social or cultural practices and behavior changes that lead to implementation of management measures and water quality improvement.
  - ⇒ Number of homeowners who participate in septic socials.
  - ⇒ Number of homeowners who participate in shoreland buffer neighborhood meetings and demonstration projects.
  - ⇒ Number of homeowners who participate in residential stormwater educational programs.
  - ⇒ Number of residents who participate in creek clean-up days.
  - ⇒ Number of requests for information (from towns and SCA).
  - ⇒ Amount of towns' and stakeholders' website hits (track webpage).
  - ⇒ Number of new SCA and KLT members.

The number of individuals who participate in watershed surveys is an example of a social indicator.

- **Environmental Indicators** are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions.
  - ⇒ Number of Spruce Creek sampling stations meeting water quality standards.
  - ⇒ Reduction in the number of closed shellfish harvesting areas.
  - ⇒ Reduction in the frequency of peak flows.

⇒ Number of acres of improved riparian habitat.
⇒ Reduction in the amount of trash found in Creek.
⇒ Number of septic systems repaired.
⇒ Reduction in levels of heavy metals, including mercury and lead.
⇒ Numbers of houses that eliminate septic systems and hook up to sewer.
⇒ Increase in the number of septic systems functioning normally and being inspected and pumped out every three years.

9.4 Estimated Costs and Technical Assistance Needed

Estimated costs for each action item are listed in Table 9.2.1. Additionally, the following agencies are either currently funding water quality protection and remediation projects or are potential sources of funding:

- National Fish and Wildlife Foundation
- Maine Department of Environmental Protection
- 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 Habitat Restoration Grants Program
- Jessie B. Cox Charitable Trust: A New England Philanthropy
- Maine Community Foundation (Fund for Maine Land Conservation)

9.5 Educational Component

This WBMP includes an educational component that will be used to enhance public understanding of the plan and encourage community participation in watershed restoration and protection activities. Efforts will be made to encourage people to identify with their own watershed and to promote stewardship of water resources. The educational goal of the plan is to elevate public understanding of these connections and to encourage actions that maintain the highest water quality and a healthy watershed ecosystem. As part of the Spruce Creek WBMP, the following educational actions will be completed:

Watershed Identification Signage

Roadside and pedestrian signage identifying local waterways will act as a step toward encouraging knowledge of and interest in the Spruce Creek watershed.

Spruce Creek Association and Town of Kittery Websites

The Spruce Creek Association website as a whole is intended as a community education resource that can provide detailed information on many aspects of Spruce Creek. It offers general information for the public-at-large along with research and water quality results that can serve academic and institutional purposes. The Town of Kittery website offers pertinent watershed-related data including maps, meeting minutes, and zoning information.

Demonstration and "Model" Sites

Buffer planting demonstration sites in high profile areas will serve to educate residents about the importance of shoreland buffers, rain gardens, and other BMPs.

Recognition and Awards for Watershed Stewardship

As part of the stormwater action plan, watershed businesses will be recognized for utilizing impervious cover reduction practices and other BMPs.

Educational Materials

Educational materials will be developed to inform residents and businesses about shoreland zoning rules, buffers, septic systems, and more.

Creek Clean-Up Days

Yearly creek clean-up days will involve landowners, students and other volunteers and will encourage stewardship.

Septic Socials

Septic socials will inform residents about the relationship between septic systems and water quality.

9.6 Monitoring Plan

Water quality monitoring will be evaluated annually both on a seasonal basis and compared with long-term water quality records to determine if improvements are occurring as implementation proceeds. When possible, water quality monitoring will be conducted before and after repair of a site in order to determine effectiveness.

9.7 Evaluation Plan

> The watershed towns and SCA will gather the stakeholders annually to review the success of the Plan. The partners will evaluate work completed and plan the next year's programs and projects.

To stay abreast of the effectiveness of the Management Plan, the SCA WBMP Steering Committee will work towards releasing (or posting to the website) an annual report that highlights the progress and activities in comparison to the timeline set forth in the Action Plan. Tasks listed in the Action Plan should be tracked and recorded as they occur, and new tasks should be added to the plan as needed. All achievements, such as press releases, outreach activities, number of sites repaired, number of volunteers, amount of funding received, number of sites documented, will be tracked. The stakeholders will use the established indicators (**Section 9.3**) to determine the effectiveness of the plan.

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Maine DMR Fecal Coliform Monitoring Data (2005). http://sprucecreekassociation.org/fecalcol.html

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Spruce Creek Water Quality Monitoring Data (2005-2007). http://sprucecreekassociation.org/monitoring.html

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Additional Web-based Resources

Cooperative Institute for Coastal and Estuarine Environmental Technology - http://ciceet.unh.edu/

FB Environmental – http://www.fbenvironmental.com

Kittery Land Trust – http://www.kitterylandtrust.org

Maine Department of Environmental Protection - http://www.maine.gov/dep

Maine Department of Inland Fisheries and Wildlife - http://www.state.me.us/ifw/fishing

Maine Department of Marine Resources - http://www.maine.gov/dmr

Maine State Planning Office - http://www.maine.gov/spo/

Mt Agamenticus to the Sea Conservation Initiative – http://www.mta2c.org

Spruce Creek Association – http://www.sprucecreekassociation.org

Town of Eliot - http://www.eliotmaine.org

Town of Kittery - http://www.kittery.org

U.S. Environmental Protection Agency – http://www.epa.gov

U.S. Fish and Wildlife Service – http://www.fws.gov

Wells National Estuarine Research Reserve - http://www.wellsreserve.org

York County Soil & Water Conservation District - http://www.yorkswcd.org

APPENDICES

A. Glossary of Terms

B. Watershed Maps

C. Regulations

D. Bacteria Model Inputs

GLOSSARY OF TERMS

Algae Bloom: A growth of algae resulting from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.

Best Management Practices (BMPs): Techniques, measures or structural controls implemented to reduce potential pollutant generation and/or facilitate pollutant removal in stormwater runoff.

Buffers (Riparian Zone): Land bordering a river, stream, or wetland for the protection of water quality, wildlife, and/or recreation.

Culvert: A conduit through which surface water can flow under or across roads and driveways. Culverts are usually a pipe and can be made of metal, wood, plastic, or concrete.

Direct Flow: Overland flow of water with attached sediments, nutrients and pollutants which causes increased surface runoff to nearby water bodies. This type of flow is enhanced by, and associated with other NPS problems such as inadequate buffers, and poorly designed or failing culverts and ditches.

Dissolved Oxygen (DO): Oxygen dissolved in the water is essential for all plants and animals living in the water. DO is a measurement of the amount of oxygen in the water that is available to these plants and animals. The amount of DO is used as an indicator of water quality and the level of life that the water can support.

Diversion: A BMP used to intercept and direct surface runoff. Diversions are usually channels or depressions with a supporting ridge on the lower side, constructed across or at the bottom of a slope.

Ecosystem: A system formed by the interaction of a community of organisms with its environment.

Erosion: Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical and chemical forces. Human activities can greatly speed this process.

Fecal Coliform Bacteria: A group of bacteria that are passed through the fecal excrement of humans, livestock, and wildlife. They aid in the digestion of food. Escherichia coli (E. coli) are the most common member of fecal coliform bacteria. They can be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals.

Glaciofluvial: Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames eskers, and kame terraces.

Glaciolacustrine Deposits: Sand, silt and clay deposited on the bottom of huge temporary lakes that formed either due to the melting glacial ice or by the blocking out of outlets for meltwater. Sand, silt and clay remains suspended in fast-moving river water, but in slow-moving water such as lakes these fine materials are deposited.

Leach Field: The part of a septic system where the effluent from the septic tank disperses into the soil.

Mulch: A layer of hay or other material covering the land surface that holds soil in place. It aids in the establishment of vegetation by preventing erosion, conserving moisture, and minimizing temperature fluctuations.

Nonpoint Source Pollution (NPS): Polluted runoff that cannot be traced to a specific origin or starting point, but accumulates from overland flow from many different watershed sources.

Overboard Discharges (OBDs): The discharge of wastewater from residential, commercial, and publicly owned facilities to streams, rivers lakes, and the ocean.

Phosphorus: An element found throughout the environment; it is a nutrient essential to all living organisms. Phosphorus binds to soil particles, is found in fertilizers, sewage, and motor oil, and is found in high concentrations in stormwater runoff. The amount of phosphorus present in a lake determines the lake's production of algae. A very small change in phosphorus levels can dramatically increase algae growth.

Point Source Pollution: Readily identifiable inputs where waste is discharged to the receiving waters from a pipe or drain. Most industrial wastes are discharged to rivers and the sea in this way. With few exceptions, most point source waste discharges, are controlled by EPA.

Runoff: Water that drains or flows across the surface of the land.

Sediment: Mineral and organic soil material that is transported in suspension by wind or flowing water, from its origin in another location.

Septic System: An individual sewage treatment system that typically includes a septic tank and leach field that area buried in the ground. The septic tank allows sludge to settle to the bottom and a scum of fats, greases and other lightweight materials to rise to the top. The remaining liquid flows to the leach field where it disperses through soil to reduce the number of bacteria and viruses.

Shoreland: The area of land from the water line stretching inland. The definition of this distance may vary by county zoning and state definitions.

TMDL: A Total Maximum Daily Load is an acronym for Total Maximum Daily Load, which represents the total amount of a pollutant (e.g., bacteria) that a waterbody can receive while still meeting water quality standards.

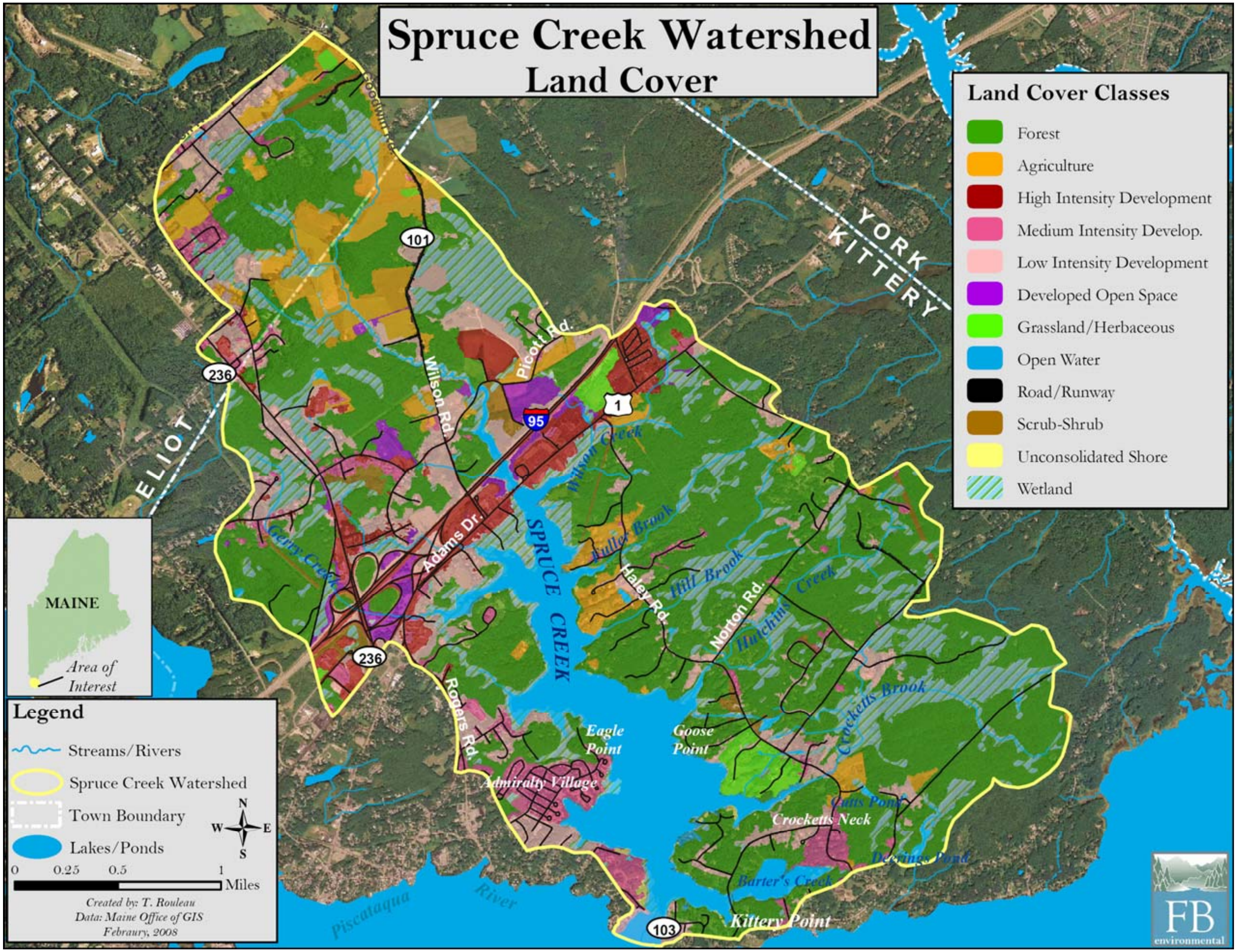
Tributaries: Streams or rivers that flow to a large body of water.

Vegetated Buffer: Areas of vegetation, left undisturbed or planted between a developed area and a waterbody that are used to capture pollutants from surface water and groundwater. Buffer vegetation can include trees, shrubs, bushes, and ground cover plants.

Vernal Pools: Seasonally flooded depressions found on ancient soils with an impermeable layer such as a hardpan, claypan, or volcanic basalt.

Water Quality: Pertaining to the presence and amounts of pollutants in water.

Watershed: The geographic region within which water drains into a particular river, stream, or body of water. A watershed includes hills, lowlands, and the body of water into which the land drains. Watershed boundaries are defined by the ridges of land separating watersheds.


Spruce Creek Watershed
Land Cover
Land Cover Classes
Forest
Agriculture
High Intensity Development
Medium Intensity Develop.
Low Intensity Development
Developed Open Space
Grassland/Herbaceous
Open Water
Road/Runway
Scrub-Shrub
Unconsolidated Shore
Wetland
YORK
KITTERY
ELIOT
Wilson Rd.
Picott Rd.
Adams Dr.
Haley Rd.
Norton Rd.
Rogers Rd.
SPRUCE CREEK
Eagle Point
Goose Point
Admiralty Village
Crocketts Neck
Kittery Point
Barter's Creek
Crocketts Brook
Hill Brook
Wilson Creek
Gerry Creek
Piscataqua River
101
236
95
1
103
MAINE
Area of Interest
Legend
Streams/Rivers
Spruce Creek Watershed
Town Boundary
Lakes/Ponds
0 0.25 0.5 1 Miles
N
S
E
W
Created by: T. Rouleau
Data: Maine Office of GIS
Febraury, 2008
FB environmental

Map 1

Maine Land Cover Class Descriptions

Developed High Intensity - Includes highly developed areas where people reside or work in high numbers. Impervious surfaces account for 80 to 100 percent of the total cover. Characteristic land cover features: Large commercial/industrial complexes and associated parking, commercial strip development, large barns, hangars, interstate highways, and runways.

Developed Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover. Characteristic land cover features: Small buildings such as single family housing units, farm outbuildings, and large sheds.

Developed Low Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 21 to 49 percent of total cover. Characteristic land cover features: Same as Medium Intensity Developed with the addition of streets and roads with associated trees and grasses. If roads or portions of roads are present in the imagery they are represented as this class in the final land cover product.

Developed Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. Characteristic land cover features: Parks, lawns, athletic fields, golf courses, and natural grasses occurring around airports and industrial sites.

Agriculture-

***Cultivated land* -** Areas used for the production of annual crops. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled. Characteristic land cover features: Crops (corn, soybeans, vegetables, tobacco, and cotton), orchards, nurseries, and vineyards.

***Pasture/Hay* -** Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle and not tilled. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation. Characteristic land cover features: Crops such as alfalfa, hay, and winter wheat.

Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Includes managed and unmanaged forest.

Grassland/Herbaceous - Areas dominated by herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing. Characteristic land cover features: Prairies, meadows, fallow fields, clear-cuts with natural grasses, and undeveloped lands with naturally occurring grasses.

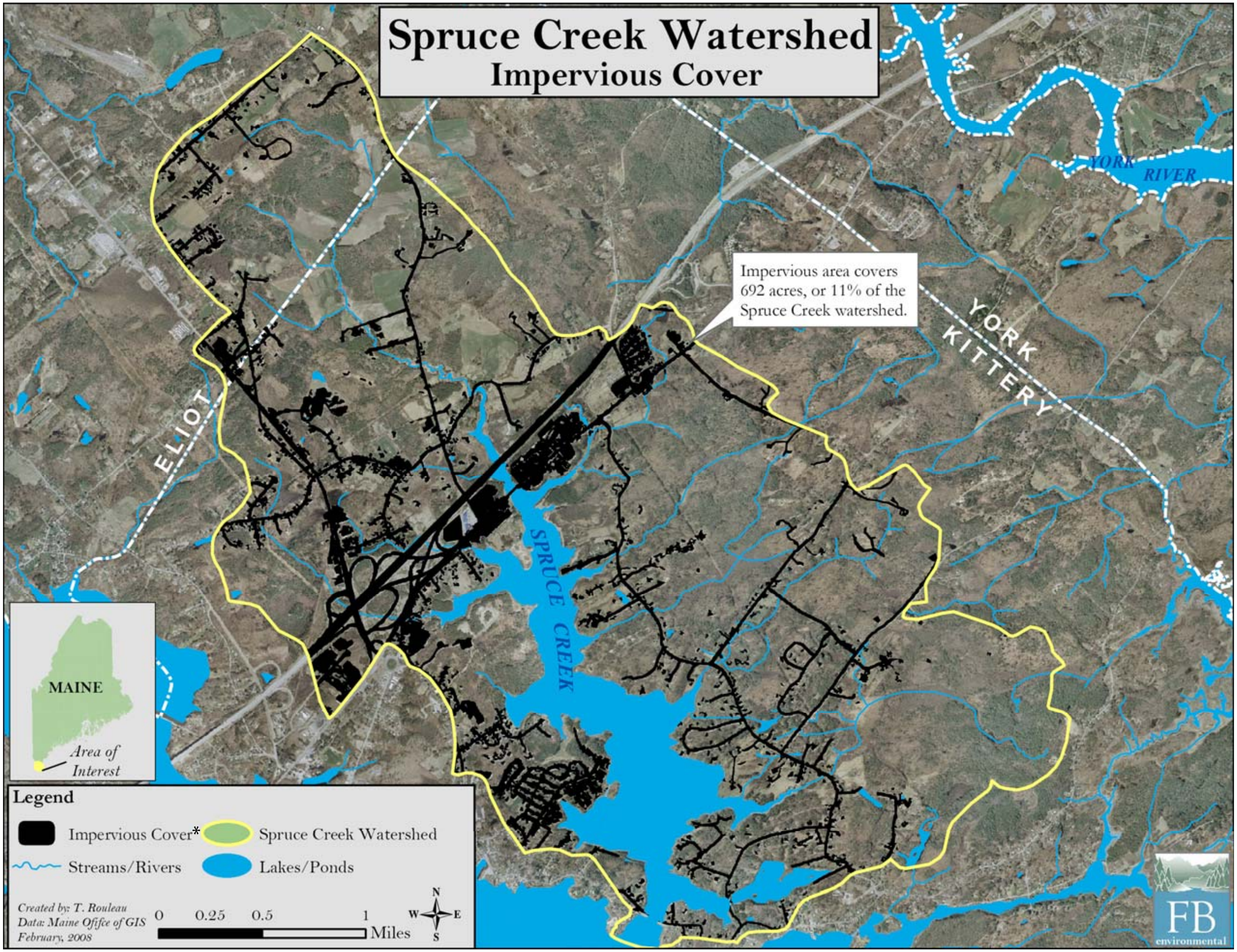
Wetlands - Palustrine Scrub-Shrub, Palustrine Emergent, Estuarine Scrub-Shrub, and Estuarine Emergent wetlands.

Road/Runway-Developed High Intensity Sub-type includes some of Maine's major highways and most airports with paved runways.

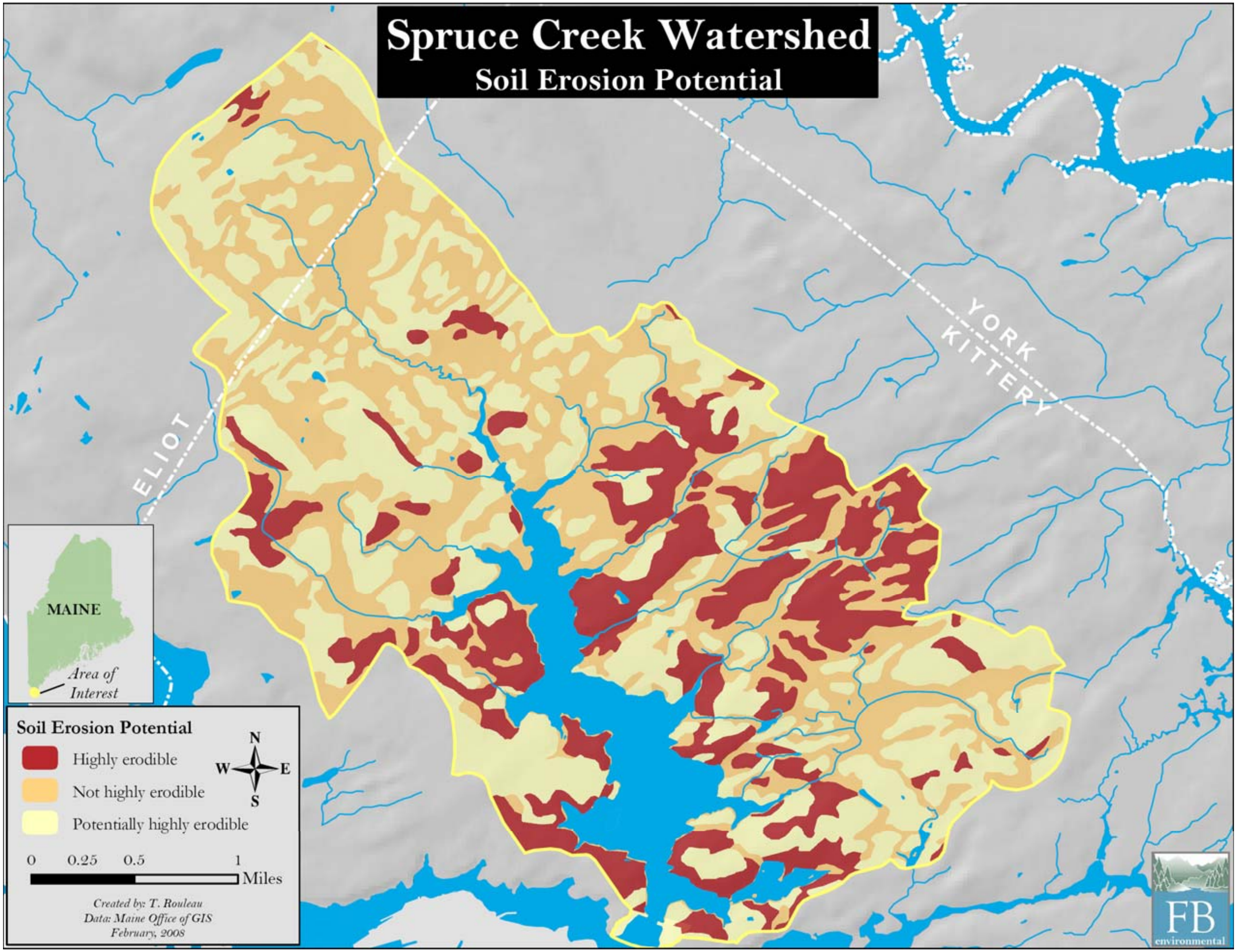
Unconsolidated Shore - Unconsolidated material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms representing this class.

Open Water - All areas of open water, generally with less than 25 percent cover of vegetation or soil. Characteristic land cover features: Lakes, rivers, reservoirs, streams, ponds, and ocean.

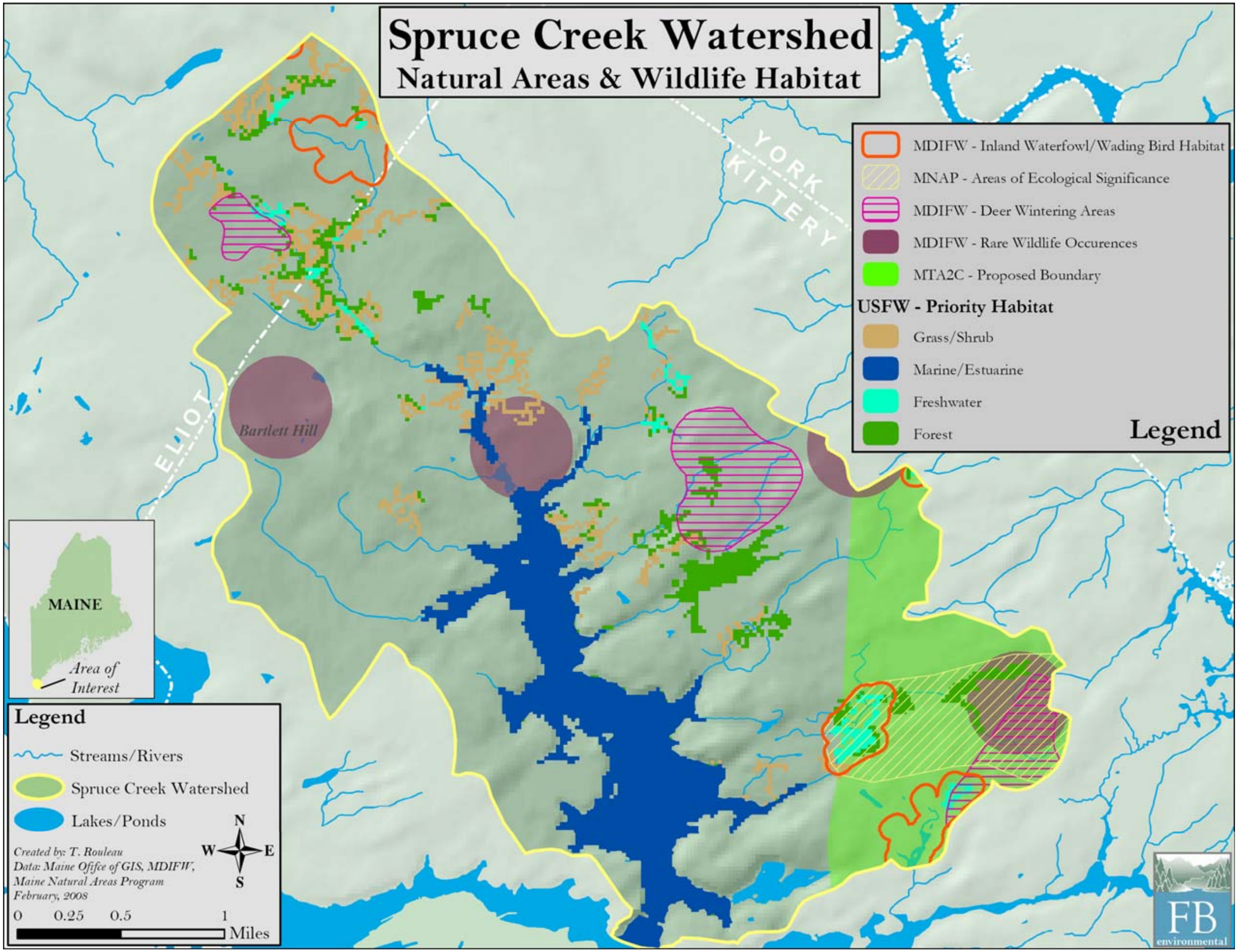
(Source: Maine Office of GIS)



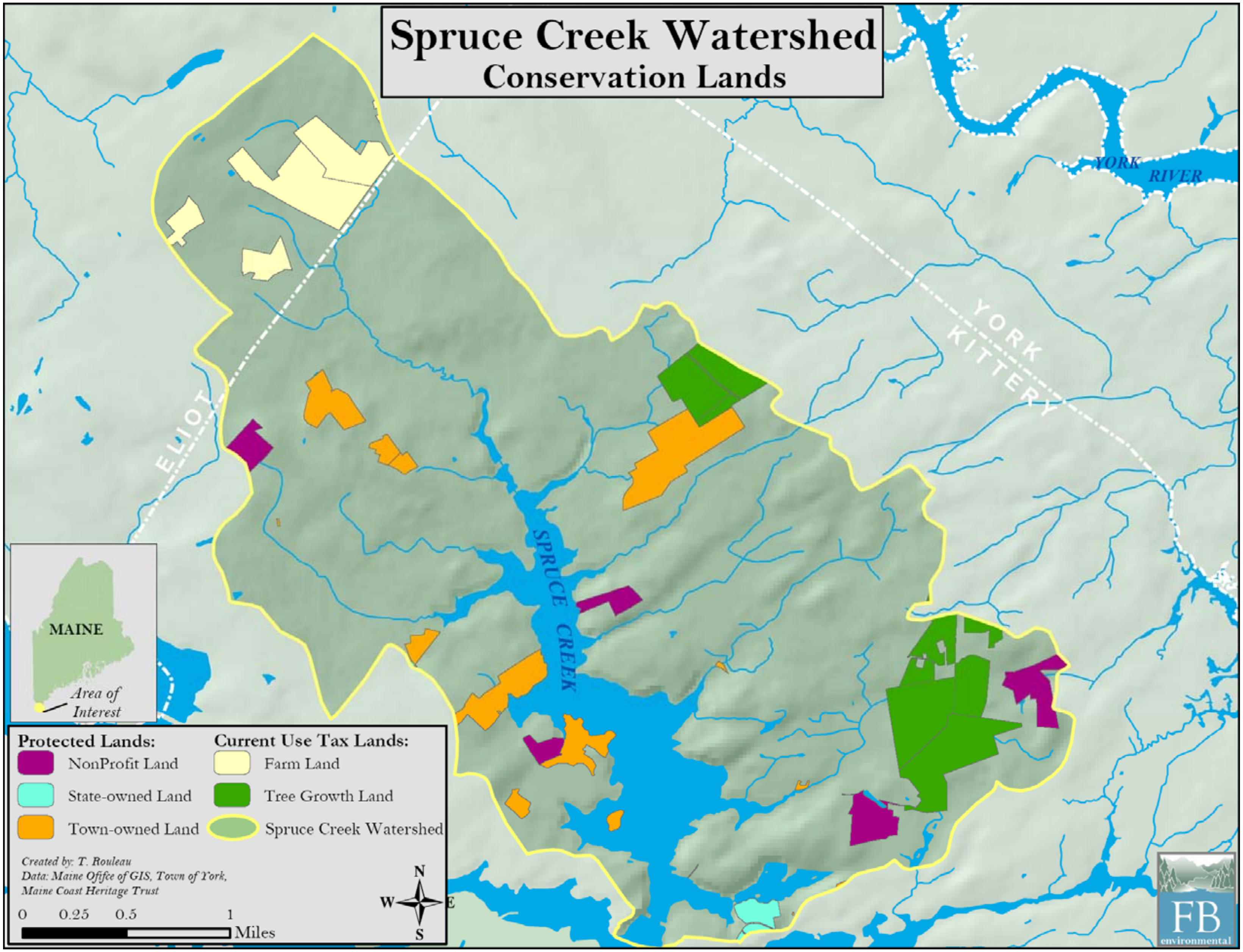
Map 2 **Derived from 5 meter ortho-imagery collected in the summer of 2004 over the State of Maine. Areas of imperviousness are characterized by anthropogenic features such as buildings, roads, parking lots, etc.*


Spruce Creek Watershed
Soil Erosion Potential
YORK
KITTERY
ELIOT
MAINE
Area of Interest
Soil Erosion Potential
Highly erodible
Not highly erodible
Potentially highly erodible
N
W
E
S
0 0.25 0.5 1 Miles
Created by: T. Rouleau
Data: Maine Office of GIS
February, 2008
FB environmental

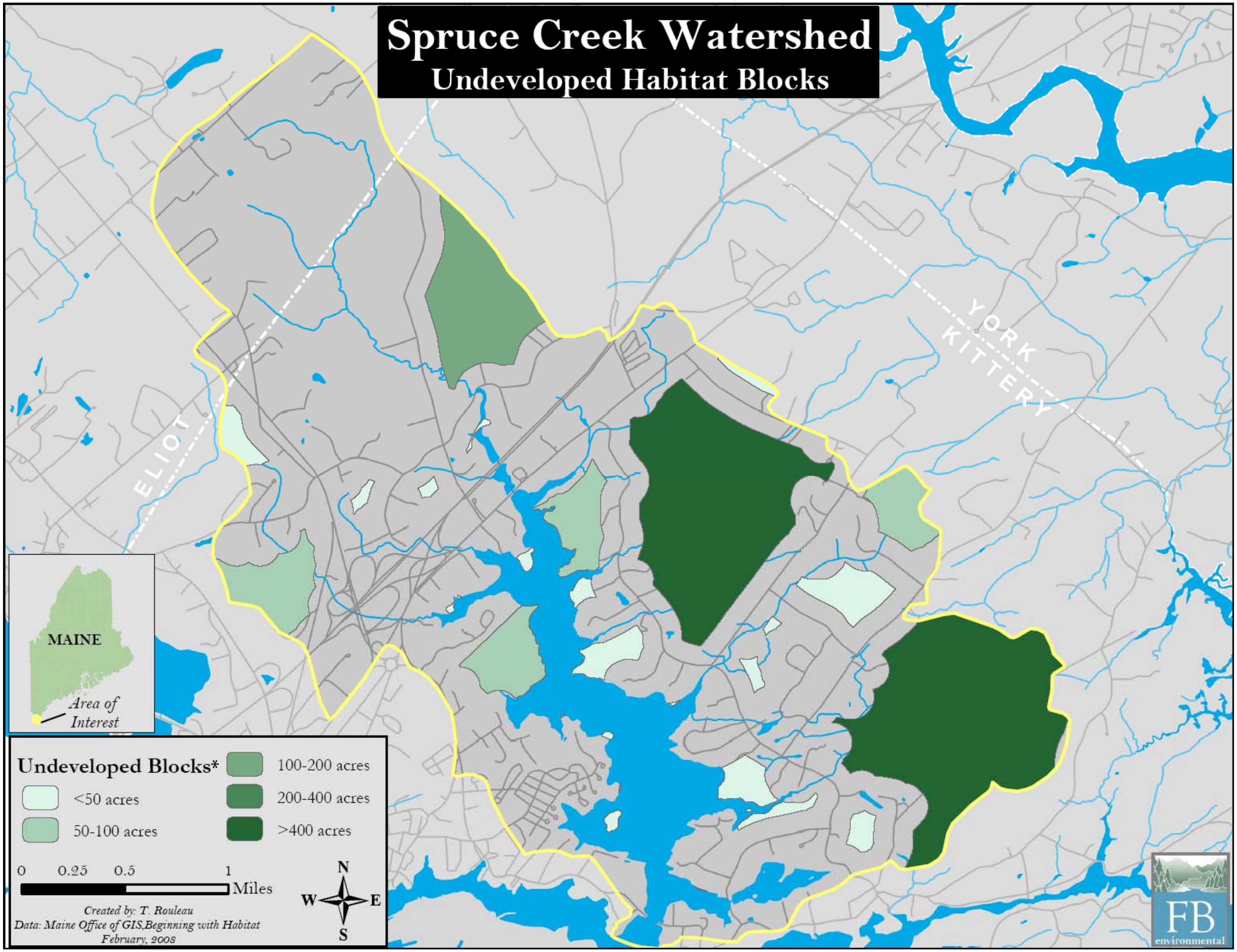
Map 3


Spruce Creek Watershed
Natural Areas & Wildlife Habitat
MDIFW - Inland Waterfowl/Wading Bird Habitat
MNAP - Areas of Ecological Significance
MDIFW - Deer Wintering Areas
MDIFW - Rare Wildlife Occurences
MTA2C - Proposed Boundary
USFW - Priority Habitat
Grass/Shrub
Marine/Estuarine
Freshwater
Forest
Legend
YORK
KITTERY
ELIOT
Bartlett Hill
MAINE
Area of Interest
Legend
Streams/Rivers
Spruce Creek Watershed
Lakes/Ponds
N
W
E
S
Created by: T. Rouleau
Data: Maine Office of GIS, MDIFW, Maine Natural Areas Program
February, 2008
0 0.25 0.5 1 Miles
FB environmental

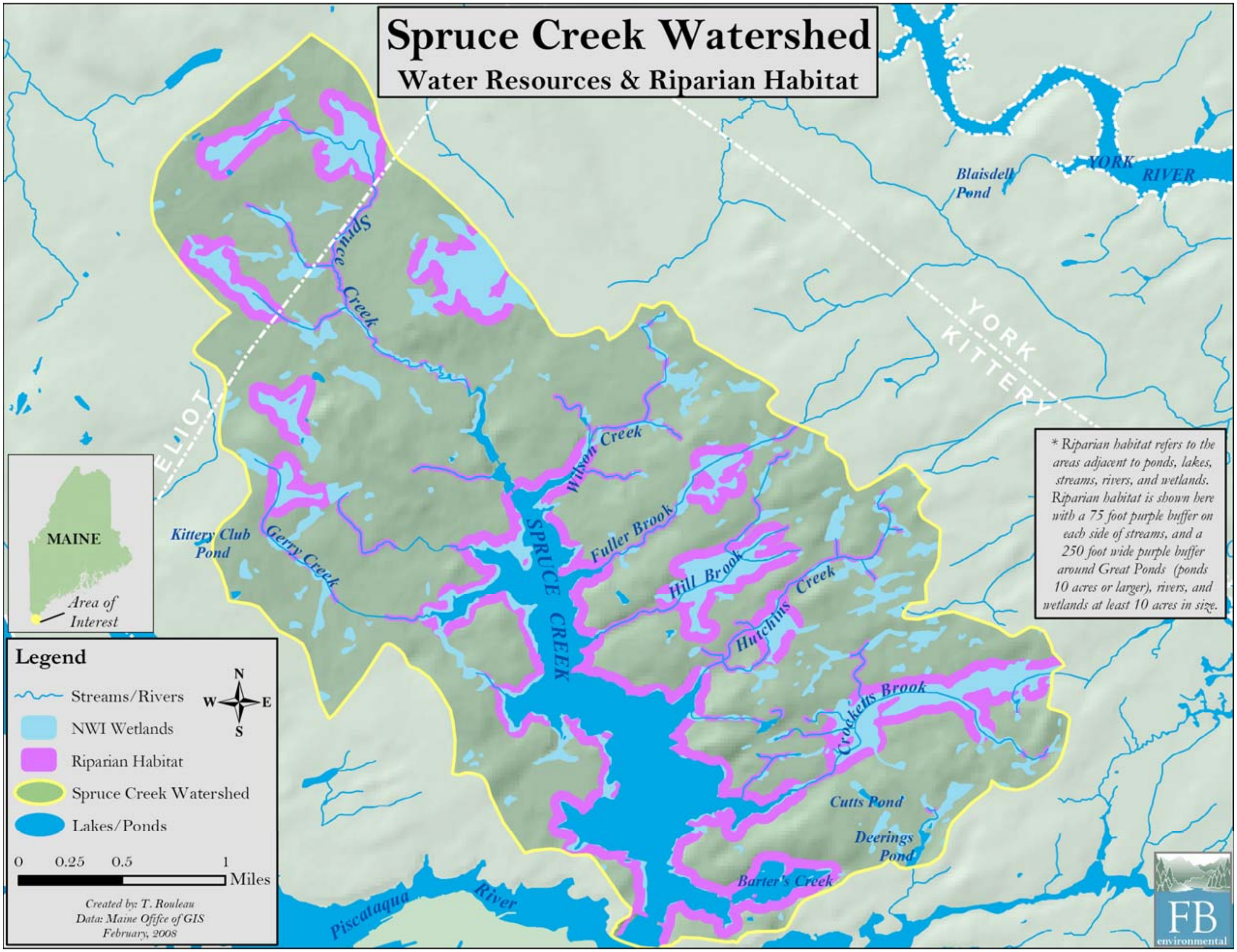
Map 4


Spruce Creek Watershed
Conservation Lands
YORK RIVER
YORK
KITTERY
ELIOT
SPRUCE CREEK
MAINE
Area of Interest
Protected Lands:
NonProfit Land
State-owned Land
Town-owned Land
Current Use Tax Lands:
Farm Land
Tree Growth Land
Spruce Creek Watershed
Created by: T. Rouleau
Data: Maine Office of GIS, Town of York, Maine Coast Heritage Trust
0 0.25 0.5 1 Miles
N S W E
FB environmental

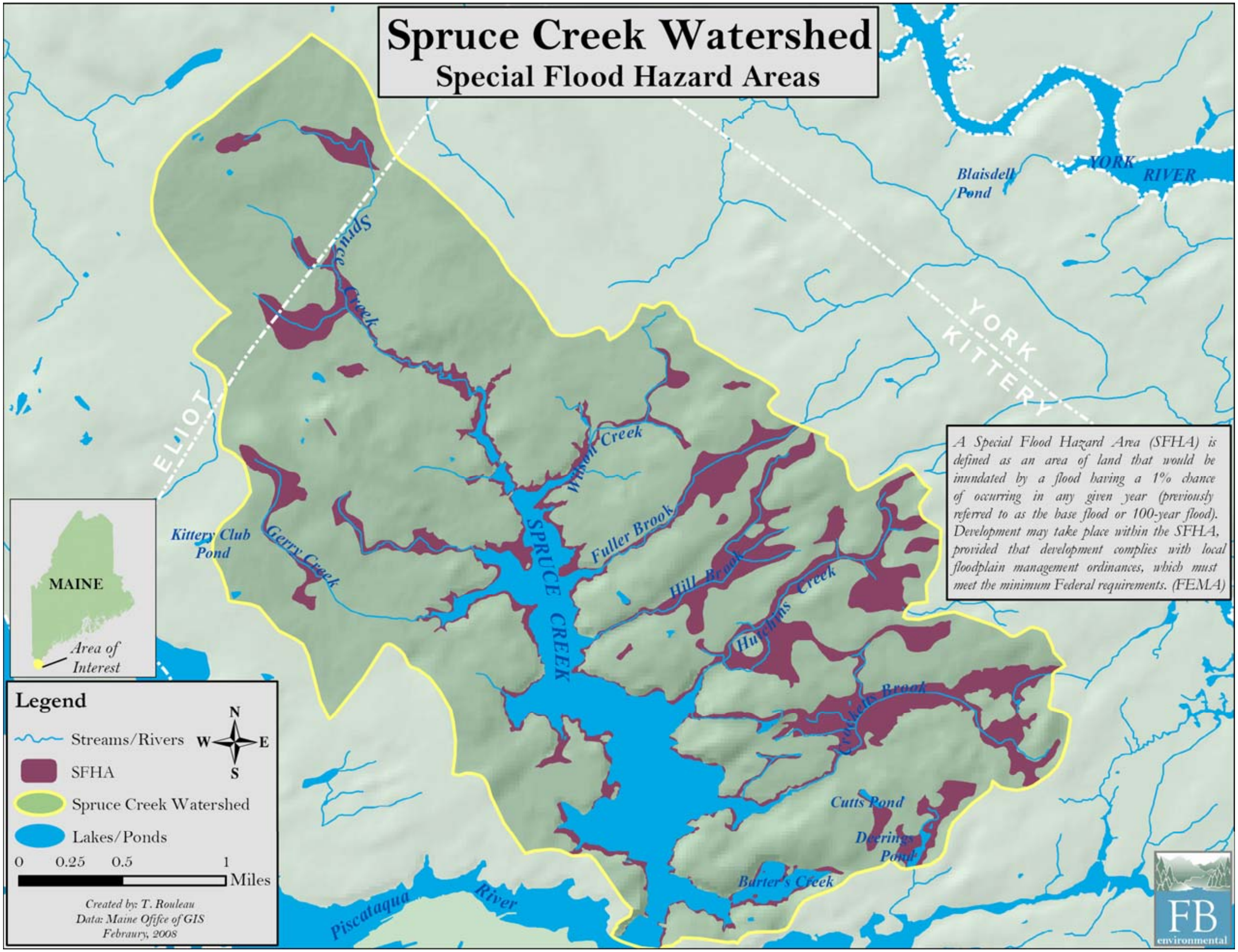
Map 5



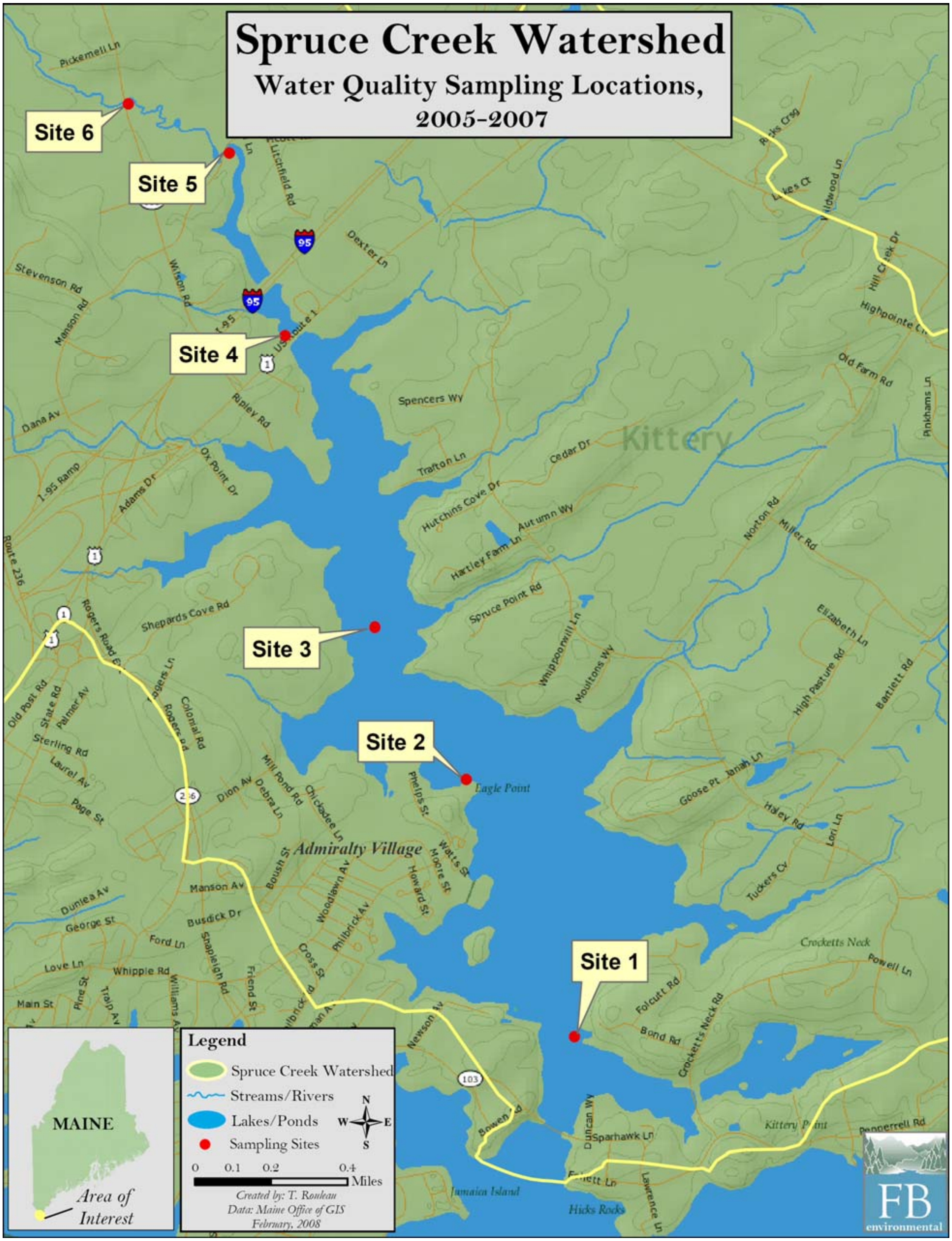
Map 6 *"Large blocks" are relatively unbroken areas of habitat that include forest, grassland/agricultural land, and wetlands. "Unbroken" means that the habitat is crossed by few roads, and has relatively little development and human habitation (GIS data developed by Beginning with Habitat and edited by FBE).*


Spruce Creek Watershed
Water Resources & Riparian Habitat
* Riparian habitat refers to the areas adjacent to ponds, lakes, streams, rivers, and wetlands. Riparian habitat is shown here with a 75 foot purple buffer on each side of streams, and a 250 foot wide purple buffer around Great Ponds (ponds 10 acres or larger), rivers, and wetlands at least 10 acres in size.
Legend
Streams/Rivers
NWI Wetlands
Riparian Habitat
Spruce Creek Watershed
Lakes/Ponds
N
S
E
W
0
0.25
0.5
1
Miles
Created by: T. Rouleau
Data: Maine Office of GIS
February, 2008
MAINE
Area of Interest
YORK RIVER
Blaisdell Pond
YORK
KITTERY
ELIOT
Kittery Club Pond
Spruce Creek
Gerry Creek
Wilson Creek
Fuller Brook
SPRUCE CREEK
Hill Brook
Hutchins Creek
Crocketts Brook
Cutts Pond
Deerings Pond
Barter's Creek
Piscataqua River
FB
environmental

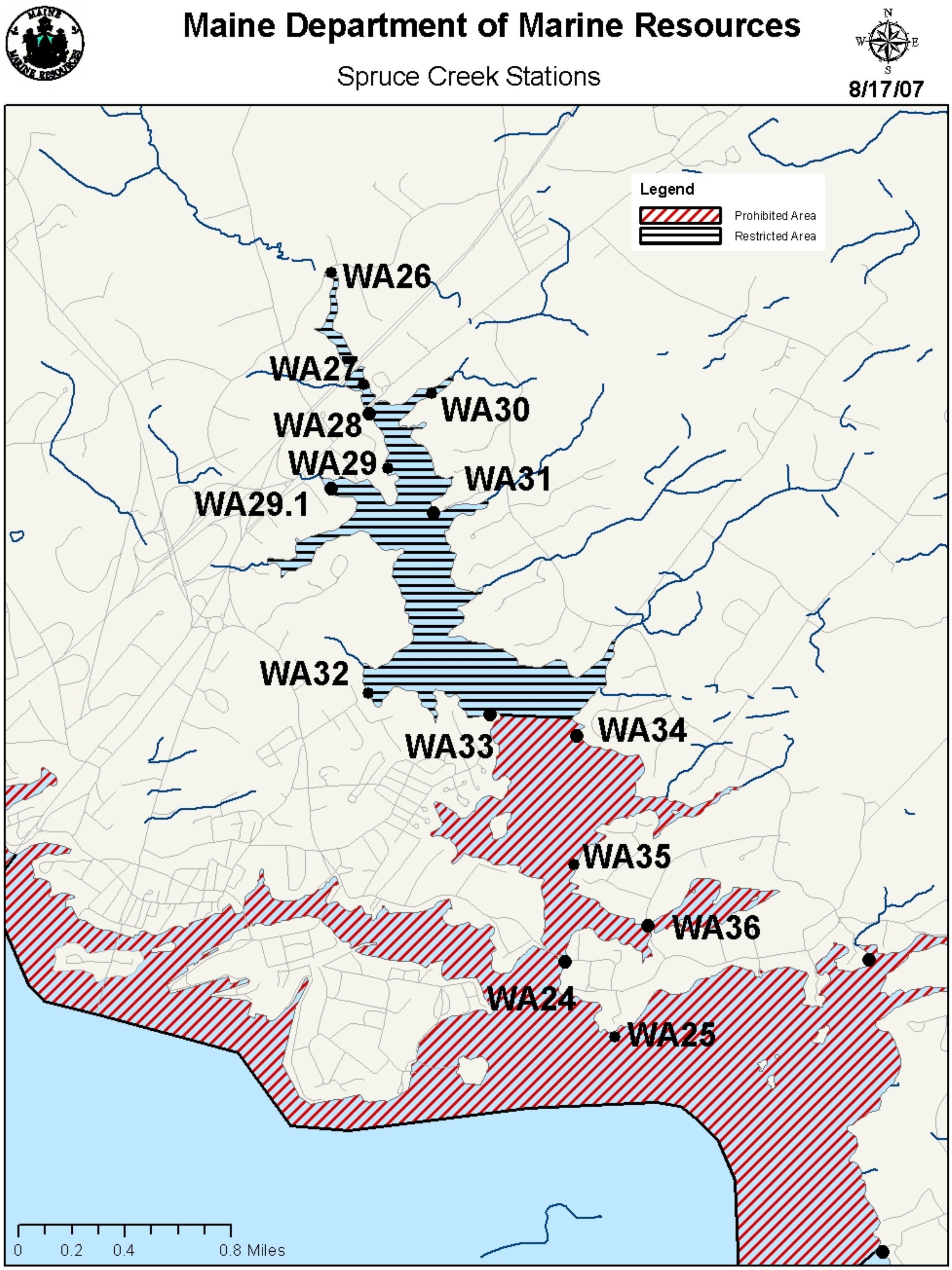
Map 7


Spruce Creek Watershed
Special Flood Hazard Areas
A Special Flood Hazard Area (SFHA) is defined as an area of land that would be inundated by a flood having a 1% chance of occurring in any given year (previously referred to as the base flood or 100-year flood). Development may take place within the SFHA, provided that development complies with local floodplain management ordinances, which must meet the minimum Federal requirements. (FEMA)
YORK RIVER
Blaisdell Pond
YORK
KITTERY
ELIOT
Spruce Creek
Wilson Creek
Fuller Brook
Hill Brook
Hutchins Creek
Crocketts Brook
Gerry Creek
Kittery Club Pond
SPRUCE CREEK
Cutts Pond
Deerings Pond
Barter's Creek
Piscataqua River
MAINE
Area of Interest
Legend
Streams/Rivers
SFHA
Spruce Creek Watershed
Lakes/Ponds
N
S
W
E
0
0.25
0.5
1
Miles
Created by: T. Rouleau
Data: Maine Offfce of GIS
Febraury, 2008

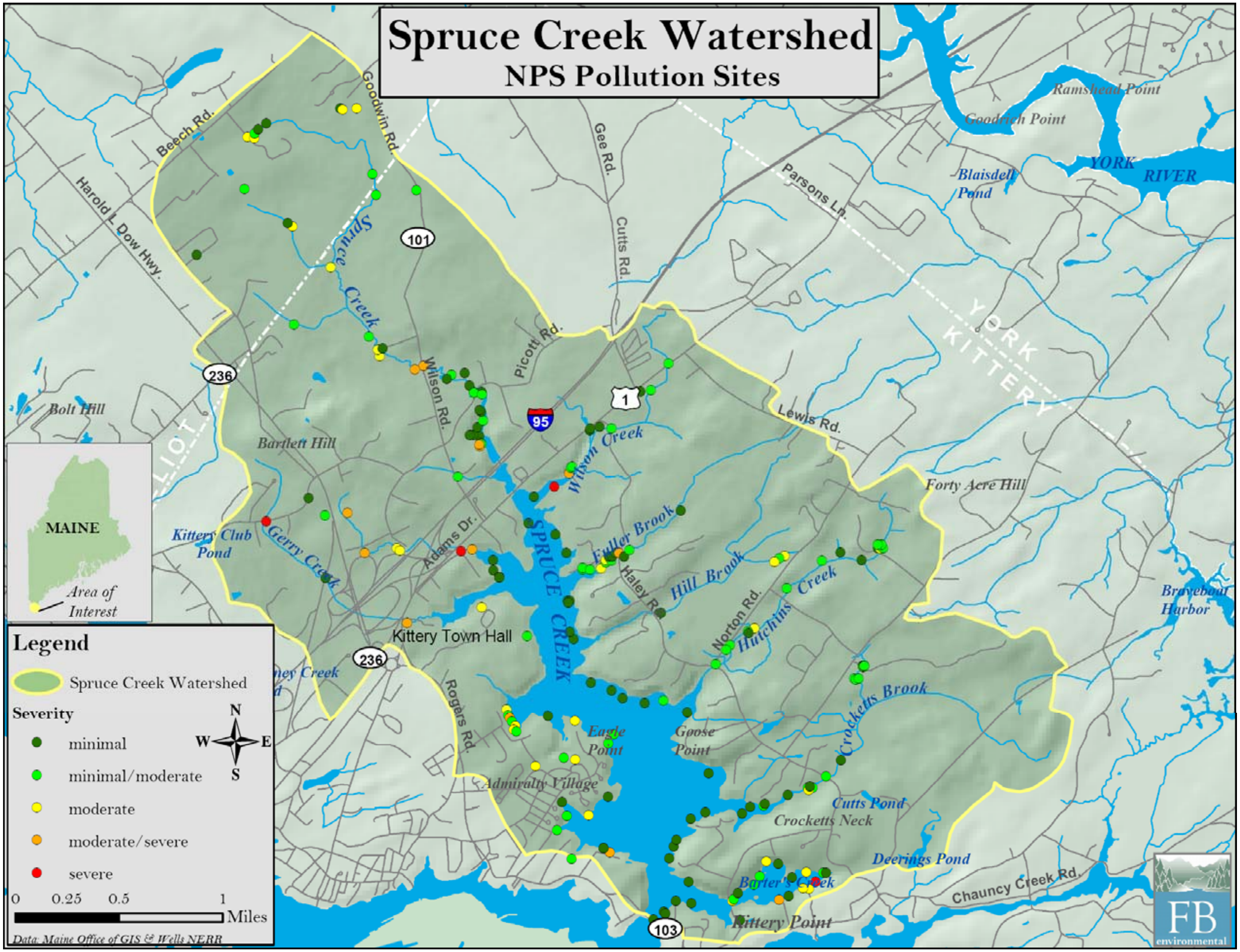
Map 8


Spruce Creek Watershed
Water Quality Sampling Locations, 2005-2007
Site 6
Site 5
Site 4
Site 3
Site 2
Site 1
Kittery
Admiralty Village
Eagle Point
Crocketts Neck
Kittery Point
Jamaica Island
Hicks Rocks
Pickernell Ln
Litchfield Rd
Dexter Ln
Stevenson Rd
Manson Rd
Wilson Rd
US Route 1
Spencers Wy
Ripley Rd
Dana Av
Ox Point Dr
I-95 Ramp
Adams Dr
Trafton Ln
Cedar Dr
Hutchins Cove Dr
Autumn Wy
Hartley Farm Ln
Route 236
Shepards Cove Rd
Spruce Point Rd
Whippoorwill Ln
Moultons Wy
Norton Rd
Miller Rd
Elizabeth Ln
High Pasture Rd
Bartlett Rd
Old Farm Rd
Highpointe Cir
Pinkhams Ln
Old Post Rd
State Rd
Palmer Av
Sterling Rd
Laurel Av
Page St
Colonial Rd
Rogers Rd
Dion Av
Debra Ln
Mill Pond Rd
Chickadee Ln
Phelps St
Goose Pt
Haley Rd
Lori Ln
Tuckers Cv
Dunlea Av
George St
Manson Av
Busdick Dr
Woodlawn Av
Philbrick Av
Howard St
Watts St
Moore St
Ford Ln
Love Ln
Whipple Rd
Main St
Shapleigh Rd
Friend St
Cross St
Newson Av
Folcutt Rd
Bond Rd
Crocketts Neck Rd
Powell Ln
Bowen Rd
Duncan Wy
Sparhawk Ln
Lawrence Ln
Pepperrell Rd
MAINE
Area of Interest
Legend
Spruce Creek Watershed
Streams/Rivers
Lakes/Ponds
Sampling Sites
N
S
E
W
0 0.1 0.2 0.4 Miles
Created by: T. Rouleau
Data: Maine Office of GIS
February, 2008
FB environmental

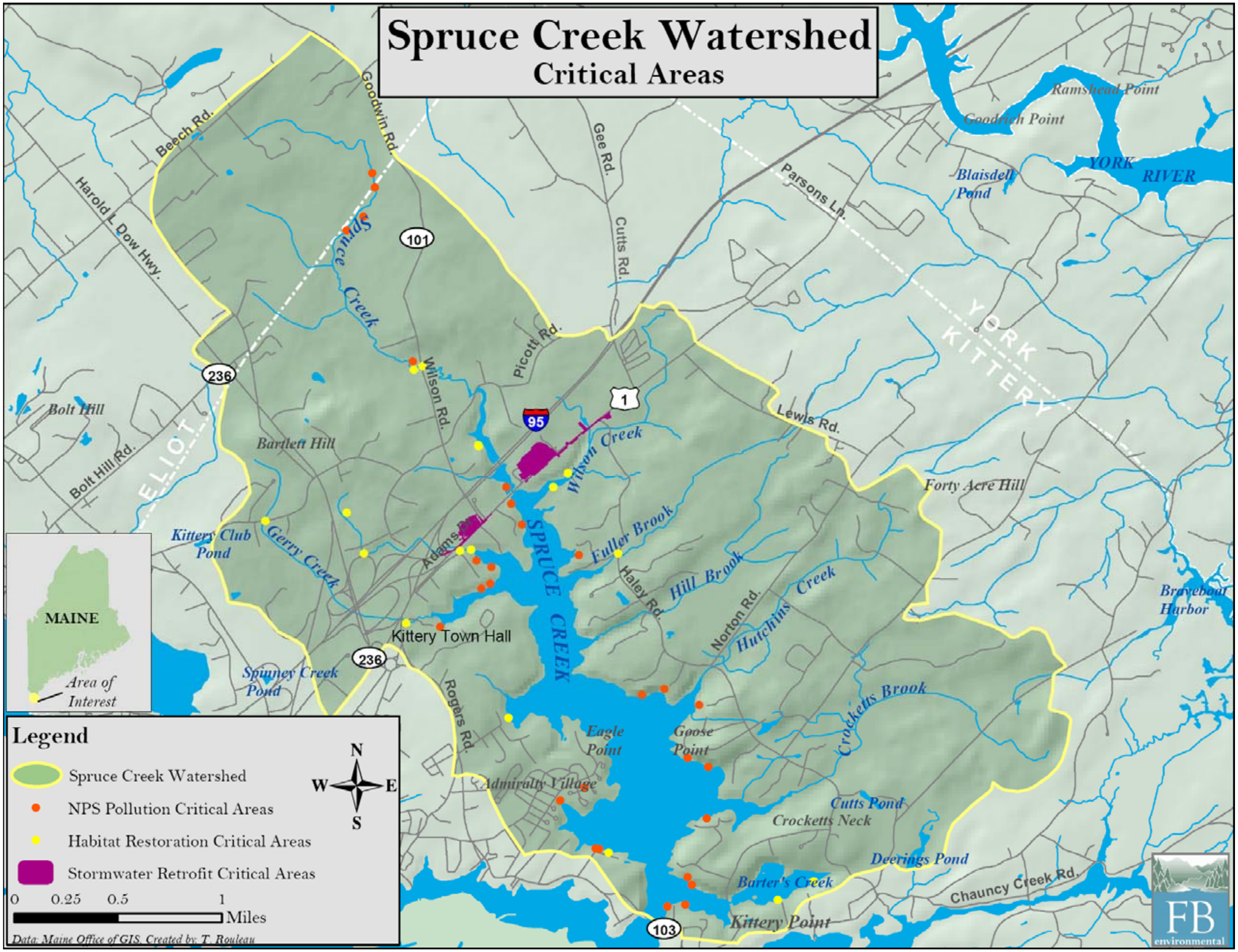
Map 9



Map 10 ** Note: As of 2/1/08, all Spruce Creek sites were listed as "Prohibited".*


Spruce Creek Watershed
NPS Pollution Sites
Legend
Spruce Creek Watershed
Severity
minimal
minimal/moderate
moderate
moderate/severe
severe
0 0.25 0.5 1
Miles
Data: Maine Office of GIS & Wells NERR
MAINE
Area of Interest
Spruce Creek
Wilson Creek
Fuller Brook
Hill Brook
Hutchins Creek
Crocketts Brook
Gerry Creek
Barter's Creek
Kittery Town Hall
Kittery Point
Crocketts Neck
Cutts Pond
Deerings Pond
Eagle Point
Goose Point
Admiralty Village
Bartlett Hill
Bolt Hill
Kittery Club Pond
Forty Acre Hill
Brave Boat Harbor
Blaisdell Pond
Goodrich Point
Ramshead Point
YORK RIVER
YORK
KITTERY
Beech Rd.
Harold L Dow Hwy.
Goodwin Rd.
Wilson Rd.
Picott Rd.
Gee Rd.
Cutts Rd.
Parsons Ln.
Lewis Rd.
Adams Dr.
Haley Rd.
Norton Rd.
Rogers Rd.
Chauncy Creek Rd.
101
236
95
1
103
FB environmental

Map 11


Spruce Creek Watershed
Critical Areas
Ramshead Point
Goodrich Point
YORK RIVER
Blaisdell Pond
Goodwin Rd.
Beech Rd.
Gee Rd.
Cutts Rd.
Parsons Ln.
Harold L Dow Hwy.
101
Spruce Creek
YORK
KITTERY
Picott Rd.
236
Bolt Hill
Wilson Rd.
1
95
Lewis Rd.
Bartlett Hill
Wilson Creek
Bolt Hill Rd.
ELIOT
Forty Acre Hill
Kittery Club Pond
Gerry Creek
Adams Rd.
Fuller Brook
SPRUCE CREEK
Haley Rd.
Hill Brook
Norton Rd.
Hutchins Creek
Braveboat Harbor
MAINE
Kittery Town Hall
Spinney Creek Pond
Area of Interest
Crocketts Brook
Eagle Point
Goose Point
Rogers Rd.
Admiralty Village
Cutts Pond
Crocketts Neck
Deerings Pond
Barter's Creek
Chauncy Creek Rd.
Kittery Point
103
Legend
Spruce Creek Watershed
NPS Pollution Critical Areas
Habitat Restoration Critical Areas
Stormwater Retrofit Critical Areas
N
W
E
S
0
0.25
0.5
1
Miles
Data: Maine Office of GIS. Created by: T. Rouleau

Map 12

REGULATIONS

There exist a number of federal and state laws designed to protect the environment. These laws are intended to be incorporated into local town ordinances, providing protection for wildlife habitat, water and air quality, and endangered and threatened species. Major federally-mandated laws pertaining to habitat conservation and local land-use planning include:

- **Federal Endangered Species Act -** http://www.fws.gov/endangered/esa/content.html
- **Clean Water Act -** http://www4.law.cornell.edu/uscode/33/ch26.html
- **Coastal Zone Management Act -** http://www.legislative.noaa.gov/Legislation/czma.html

Additional laws mandated by the state of Maine include:

- **The Protection and Improvement of Waters Law** regulates activities which discharge or could potentially discharge materials into waters of the state (rivers, streams, brooks, lakes and ponds and tidal waters). This law requires that a license be obtained before directly or indirectly discharging any pollutant.
- **The Erosion and Sedimentation Control Law** (http://www.state.me.us/dep/blwq/docstand/stormwater/erosion.htm) regulates activities involving filling, displacing or exposing soil. The law is based on the premise that all areas drain to some type of waterbody and erosion of soil material must be prevented to keep these waterbodies from becoming degraded.
- **The Natural Resources Protection Act** (http://www.state.me.us/dep/blwq/docstand/nrpapage.htm) regulates activities in, on, over, and adjacent to lakes, ponds, rivers, streams, brooks, freshwater wetlands and tidal areas. Activities regulated under the NRPA include disturbing soil, placing fill, dredging, removing or displacing soil, sand or vegetation, draining or dewatering, and building permanent structures, in, on, over or adjacent to these areas.
- **The Seasonal Conversion Law** (http://janus.state.me.us/legis/statutes/30-a/title30-Asec4215.pdf) was enacted to regulate the conversion of seasonal dwellings within the shoreland zone to year round use.
- **Shoreland Zoning** (http://www.state.me.us/dep/blwq/docstand/szpage.htm)was enacted to prevent water pollution, and damage to the natural beauty and habitat provided by Maine's surface waters. The law targets development along the immediate shoreline of these resources and requires towns to enact a shoreland zoning ordinance at least as stringent as a model ordinance developed by the state.
- **The Maine Endangered Species Act** (http://maine.gov/ifw/wildlife/species/endangered_species/es_act_part13.htm)was passed in 1975 by the State Legislature. The Act provides MDIFW with a mandate to conserve all of the species of fish and wildlife found in the State, as well as the ecosystems upon which they depend. (Source: http://maine.gov/ifw/wildlife/species/endangered_species/es_act_part13.htm)
- **The Coastal Management Policy** (http://janus.state.me.us/legis/statutes/38/title38sec1801.html), established in 1978 in Maine, establishes that there are special needs in the conservation and development of the State's coastal resources that require a statement of legislative policy and intent with respect to state and local actions affecting the Maine coast, including:

  1. Port and harbor development. Promote the maintenance, development and revitalization of the State's ports and harbors for fishing, transportation and recreation;

  2. Marine resource management. Manage the marine environment and its related resources to preserve and improve the ecological integrity and diversity of marine communities and habitats, to expand our understanding of the productivity of the Gulf of Maine and coastal waters and to enhance the economic value of the State's renewable marine resources;

3. Shoreline management and access. Support shoreline management that gives preference to water-dependent uses over other uses, that promotes public access to the shoreline and that considers the cumulative effects of development on coastal resources;

4. Hazard area development. Discourage growth and new development in coastal areas where, because of coastal storms, flooding, landslides or sea-level rise, it is hazardous to human health and safety;

5. State and local cooperative management. Encourage and support cooperative state and municipal management of coastal resources;

6. Scenic and natural areas protection. Protect and manage critical habitat and natural areas of state and national significance and maintain the scenic beauty and character of the coast even in areas where development occurs;

7. Recreation and tourism. Expand the opportunities for outdoor recreation and encourage appropriate coastal tourist activities and development;

8. Water quality. Restore and maintain the quality of our fresh, marine and estuarine waters to allow for the broadest possible diversity of public and private uses; and

9. Air quality. Restore and maintain coastal air quality to protect the health of citizens and visitors and to protect enjoyment of the natural beauty and maritime characteristics of the Maine coast." (Source: http://janus.state.me.us/legis/statutes/38/title38sec1801.html)

- **The Comprehensive Planning and Land Use Regulation Act (also known as the "Growth Management Act")** (http://janus.state.me.us/legis/statutes/30-a/title30-Ach187sec0.html), enacted in 1988, established a cooperative program of Comprehensive Planning and Land Use Management among municipalities, regional councils, and the state. Under this law, each municipality is required to develop a Local Growth Management Program that is consistent with the State goals set forth in the Act. The Growth Management Program consists of two parts: a Comprehensive Plan, and an Implementation Program that includes a zoning ordinance.
- **The State Subdivision Law** (http://www.celdf.org/Portals/0/PDF/Maine%20-%20home%20rule%20and%20subdivisions.pdf) requires municipalities to review and approve proposed or expanded subdivisions. Under this regulation, a subdivision refers to a division of a parcel of land into three or more lots within any five-year period that begins on or after September 23, 1971. The term subdivision also includes the division of an existing structure previously used for commercial or industrial purposes into three or more dwelling units.
- **The Site Location of Development Law** (http://maine.gov/dep/blwq/docstand/sitelawpage.htm) requires review of developments that may have a substantial effect upon the environment. These types of development have been identified by the Legislature, and include developments such as projects occupying more than 20 acres, metallic mineral and advanced exploration projects, large structures and subdivisions, and oil terminal facilities. A permit is issued if the project meets applicable standards addressing areas such as stormwater management, groundwater protection, infrastructure, wildlife and fisheries, noise, and unusual natural areas. The applicant for a new Site Law development (except for a residential subdivision with 20 or fewer developable lots) is required to attend a pre-application meeting. This meeting is an opportunity for the applicant to determine the requirements that apply to the project. The meeting with licensing staff is intended to help identify

issues, processing times, fees, and the types of information and documentation necessary for the DEP to properly assess the project. Pre-application meetings are available on request when they are not required.

- **The Wetlands and Waterbodies Protection** (http://mainegov-images.informe.org/dep/blwq/rules/NRPA/2006/310.pdf) rule recognizes important roles of wetlands in our natural environment and supports the nation-wide goal of no net loss of wetland functions and values. In some cases, however, the level of mitigation necessary to achieve no net loss of wetland functions and values through construction of replacement wetlands will not be practicable, or will have an insignificant effect in protecting the State's wetlands resources. In other cases, the preservation of unprotected wetlands or adjacent uplands may achieve a greater level of protection to the environment than would be achieved by strict application of a no net loss standard through construction of replacement wetlands. Therefore, the rule recognizes that a loss in wetland functions and values may not be avoided in every instance. The purpose of this rule is to ensure that the standards set forth in Section 480-D of the Natural Resources Protection Act, Section 464, Classification of Maine Waters and Section 465, Standards for Classification of Fresh Surface Waters are met by applicants proposing regulated activities in, on, over or adjacent to a wetland or water body.
- **Stormwater Management Law** (http://www.state.me.us/dep/blwq/docstand/stormwater/storm.htm)
- **Permit By Rule** (http://mainegov-images.informe.org/dep/blwq/rules/NRPA/2006/305.pdf)
- **Waste Discharge Program** (http://www.state.me.us/dep/blwq/docstand/wastepage.htm)

The Towns of Kittery and Eliot have adopted the model Maine Shoreland Zoning Ordinance. Each water body is classified by Shoreland District. Resource Protection Districts include areas in which development would adversely affect water quality, productive habitat, biological ecosystems, or scenic and natural values. The resource Protection District includes areas within 250 feet of wetlands rated moderate or high value by MDIFW, 100 year flood plains and other areas. Limited Residential Districts include areas suitable for residential development. Limited Commercial Districts include areas of mixed, light commercial and residential uses, 2 or more contiguous acres in size, and prohibits industrial uses. General Development Districts include areas with a mix of development, and areas with a discernable pattern of industrial development. Stream Protection Districts include all areas within 75 feet of the normal high water level of a stream.

Sources:

MDEP. (2000). Maine Department of Environmental Protection Homeowner's Guide To Environmental Laws Affecting Shorefront Property in Maine's Organized Towns, DEPLW-38-C2000.

MDEP. (2007). Rule Chapters for the Department of Environmental Protection. http://maine.gov/sos/cec/rules/06/chaps06.htm.

Human Population and Septic Estimates

Spruce Creek watershed population was determined by multiplying the population for each town (based on 2000 US Census data: Kittery—9,543, Eliot—5,954) by the percent of the watershed land area within that town (Kittery - 43%, Eliot –5%). The entire portion of the watershed within Eliot was assumed to be non-sewered. The portion of the watershed within Kittery was estimated to be 40% sewered. This is based on an estimate of 40-50% sewer customers in the Town of Kittery (S. Tapley, personal communication). For the Spruce Creek watershed, the lower end of this range was used.

Livestock Estimates

Livestock in the Spruce Creek watershed were estimated to total 33 animal units (AEUs), including a combination of cows, horses, chickens, turkeys, deer geese, sheep, alpaca, goats, and miniature donkeys. This determination was based on an initial survey of livestock numbers and locations. However, a more thorough investigation is recommended.

References:

Benham, B., K. Brannan, K. Christophel, T. Dillaha, L. Henry, S. Mostaghimi, R. Wagner, J. Wynn, G. Yagow, and R. Zeckoski. 2004. Total maximum daily load development for Mossy Creek and Long Glade Run: Bacteria and general standard (Benthic) impairments. Richmond, Va.: Virginia Department of Environmental Quality.

MapTech, Inc. 2000. Fecal coliform TMDL (Total Maximum Daily Load) development for the south fork of the Blackwater River, Virginia. Richmond, Va.: Virginia Department of Environmental Quality, Virginia Department of Conservation and Recreation.

Moyer, D. L. and K. E. Hyer. 2003. Use of the hydrological simulation program – FORTRAN and bacteria source tracking for development of the fecal coliform total maximum daily load (TMDL) for Christians Creek, Augusta County, Virginia. USGS Water-Resources Investigations Report 03-4162. U.S. Geological Survey.

BACTERIA MODEL INPUTS

Land Use Estimates

The GIS land cover layer used for this analysis was created at the request of the Maine DEP Bureau of Land and Water Quality (BLWQ). Though released in 2006, the Maine Land Cover Data (MELCD) used for this analysis is a land cover map for Maine primarily derived from Landsat Thematic Mapping imagery from the years 1999-2001, which was further refined using panchromatic imagery from the spring and summer months of 2004. Land uses within these maps were further refined by the Spruce Creek Association based on field verification using ground-truthing.

Wildlife Habitat Areas and Population Estimates*

Wildlife Type	Habitat	Population Density (animal/ha-habitat)	Source of Information
Deer[1]	Entire watershed	0.12	MapTech (2000)
Raccoons[2]	Low density on forests not in high density area; high density on forest within 183m of a permanent water source or 0.8km of cropland	Low density: 0.040 High density 0.12	Virginia Department of Game and Inland Fisheries (personal communication, 2004)
Muskrats[3]	26/km of ditch or medium sized stream intersecting cropland; 13/km of ditch or medium sized stream intersecting pasture; 16/km of pond or lake edge; 81/km of low-moving river edge	[a] – see habitat column	Virginia Department of Game and Inland Fisheries (personal communication, 2004)
Beavers[4]	91-m buffer around streams and impoundments in forest and pasture	0.037	Density calculated from colony size estimates from MDC (1997) and colony density estimates by Stromayer (1999); habitat modified from estimates by MapTech (2000)
Geese[5]	91-m buffer around streams and impoundments	0.13 – off season 0.27 – peak season	Moyer and Hyer (2003)
Ducks[6]	91-m buffer around streams and impoundments	0.15 – off season 0.23 – peak season	Habitat area from Moyer and Hyer (2003)
Wild Turkey[7]	Entire watershed except urban and farmstead	0.025	Brannan et al. (2002)

[1]Spruce Creek deer population estimate = 291 (based on 2,430 ha habitat).
[2]Spruce Creek raccoon population estimate = 126 (based on 1,043 ha habitat).
[3]Spruce Creek muskrat population set at zero due to inadequate data.
[4]Spruce Creek beaver population estimate = 12 (based on 300 ha habitat)
[5]Spruce Creek geese population estimate = 65 - off season), 135 - peak season (based on 500 ha habitat)
[6]Spruce Creek duck population estimate = 75 - off season, 115 - peak season (based on 500 ha habitat)
[7]Spruce Creek turkey population estimate = 60 (based on 2,400 ha habitat).