Long Creek Watershed Management Plan

A Community-Based, Collaborative Approach to the Restoration of Long Creek

July 2009

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Long Creek Watershed
Study Area
MAINE
Study Area
Portland
International
Jetport
Clark's Pond
PORTLAND
SOUTH PORTLAND
WESTBROOK
SCARBOROUGH
Western Ave
Darling Ave
Gorham Rd
Maine Mall
Maine Mall Rd
John Roberts Rd
Philbrook Ave
Sable Oaks
Golf Course
Running Hill Rd
Cummings Rd
Colonel Westbrook
Executive Park
Spring St
County Rd
22
95
FB
environmental
N
Data Sources: Maine DEP; Maine OGIS
Coordinate System: NAD83, UTM Zone 19N, Meters
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Feet

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A COMMUNITY-BASED, COLLABORATIVE APPROACH TO THE RESTORATION OF LONG CREEK

www.restorelongcreek.org

Prepared by FB Environmental Associates, Inc.
in cooperation with Woodard & Curran and the Maine Department of Environmental Protection

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Cover photo: Clark's Pond (South Portland Land Trust)

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1. INTRODUCTION

1.1 Purpose and Background

The primary purpose of the Long Creek Watershed Management Plan is to outline a cost-effective, environmentally-responsible, and equitable strategy for restoring and protecting Long Creek and its tributaries (Figure 1a). The health of Long Creek is important to the health of Clark's Pond, the Fore River, and ultimately, the Casco Bay Estuary. Restoration is necessary because Long Creek does not meet state water quality classification standards. Development over the past several decades has converted the landscape from mostly forests and fields to commercial, light industrial, retail and transportation uses. One of the primary results of this conversion process has been the creation of impervious cover such as roads, driveways, parking lots, sidewalks, rooftops and any other impermeable surfaces of the built environment. Impervious Cover (IC) prevents water from infiltrating into the ground and acts as a conveyance for a wide variety of pollutants commonly carried into adjacent surface waters by stormwater or melting snow.

Figure 1a: *Location map/overview of the Long Creek watershed.*

The body of scientific research has established a direct correlation between IC and the health of aquatic ecosystems. It has been shown that as IC increases above 10% there is a corresponding increase in stormwater flows and degradation in water quality, stream habitat, and diversity of aquatic life. Some areas of the Long Creek watershed have an IC of greater than 60%. To document the effects of this urbanization, studies have been conducted over the past several years to assess the condition of the Long Creek watershed. These studies include:

- *A Biological, Physical, and Chemical Assessment of Two Urban Streams in Southern Maine: Long Creek & Red Brook*. Maine Department of Environmental Protection (MEDEP). 2002.
- *Fluvial Geomorphic Assessment of Long Creek and Red Brook, South Portland, Maine*. Field Geology Services. 2005.
- *Fluvial Geomorphic Assessment of Two Long Creek Tributaries, South Portland, Maine*. Field Geology Services. 2006.
- *Causal Analysis of Biological Impairment in Long Creek: A Sandy-Bottomed Stream in Coastal Southern Maine*. United States Environmental Protection Agency. 2007.

Collectively, these studies conclude that a variety of restoration efforts are needed to bring the creek and its tributaries into compliance with water quality classification standards. The Long Creek Watershed Management Plan builds upon this previous body of work by providing detailed and prioritized recommendations for key restoration opportunity areas and practices. It also establishes an implementation timeline, a monitoring and assessment program, and project milestones while allowing for an ongoing revision of watershed management action items. This "adaptive management" approach will ensure the most efficient and cost-effective progress towards water quality classification attainment by discontinuing restoration practices that do not perform as well as expected and promoting those that do.

1.2 Developing a Community-Driven Plan

The four municipalities located within the Long Creek watershed – South Portland, Westbrook, Scarborough and Portland – are all required to work towards improving conditions in Long Creek. All four communities recognized the benefits of working with each other and with the community stakeholders to address a common problem. Through a grant obtained by South Portland, the four municipalities convened and participated in a watershed planning process[1]. Direct mailings, press releases and individual contact methods were used to encourage landowners to bring their skills and experience to participate in the process. The goal was to ensure their interests and perspectives were considered. This planning process, now referred to as the "Long Creek Restoration Project" (or "the Project") has involved local officials, a number of state agencies, landowners, non-profits, and other stakeholders, who have devoted many hundreds of hours to the Project. The community-based approach will continue through the implementation of the Watershed Management Plan. Project partners expect this effort to be successful and believe that it may serve as a model for other rapidly developing urban communities across Maine, New England, and possibly the rest of the nation.

The Project developed a structure to harness community involvement and provide community oversight for plan development and implementation (Figure 1b). The Long Creek Restoration Project has been led by a Steering Committee of representatives from the four municipalities, industrial, commercial and non-profit landowners, non-profit organizations in the watershed, and several state entities. The Steering Committee held several large meetings for all watershed stakeholders, which were attended by businesses, government officials, community organizations and others interested in the Project. At these large meetings, the Steering Committee and technical consultants provided information, invited participation on committees, and solicited guidance for the plan's development and implementation. Based on stakeholder input, the Steering

1 Funding for this project was provided, in part, by the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act. Section 319 grants are administered by the Maine Department of Environmental Protection in partnership with EPA. EPA requires that nine elements be addressed in watershed plans funded by Section 319 of the Clean Water Act. Appendix 10 describes where the nine required elements are addressed in this plan.

Committee identified the most pressing issues, developed the mission and goals for the Project, identified potential resources, and ultimately approved the overall watershed restoration strategy detailed in this plan.

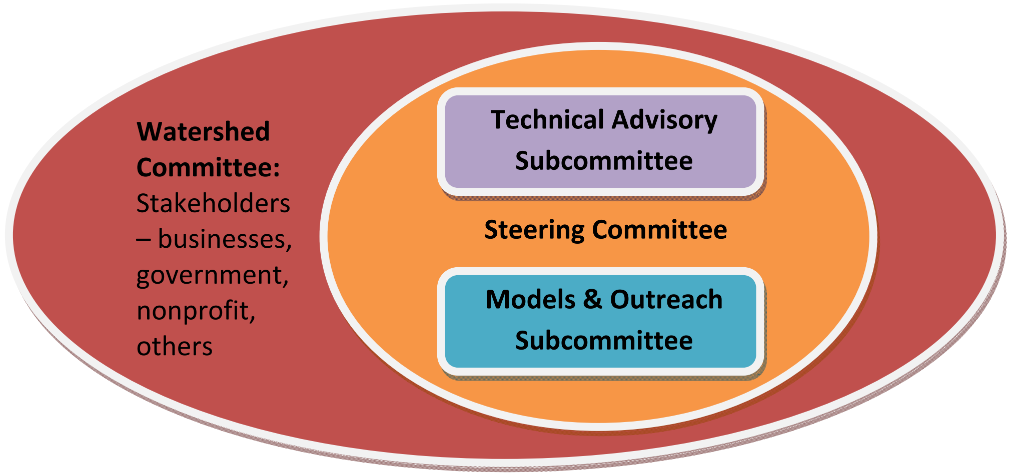


Figure 1b: *Long Creek Restoration Project committee structure.*

The Steering Committee also provided oversight to the Technical Advisory Subcommittee and the Models and Outreach Subcommittee. The charge of the Technical Advisory Subcommittee was to provide input to the Technical Consultants in the development and prioritization of restoration recommendations for the plan. The Models and Outreach Subcommittee developed an administrative and funding mechanism to implement the plan, as well as conducting ongoing public education and outreach efforts, including the development of the Project website (www.restorelongcreek.org). The Steering Committee also coordinated with Maine Department of Environmental Protection (MEDEP) and the Technical Consultants to conduct a well-attended stream tour.

1.3 Relationship to Ongoing Stormwater Mitigation Efforts in the Long Creek Watershed

The plan will dovetail with several ongoing efforts to address the adverse impacts of stormwater in the Long Creek watershed. In 2001, the MEDEP was granted the authority by the US Environmental Protection Agency (USEPA) to administer the National Pollutant Discharge Elimination System (NPDES) Stormwater Program. This program (commonly referred to as NPDES Phase II) uses an established permitting mechanism to require the implementation of controls designed to prevent pollutants from being washed into local water bodies by stormwater runoff.

Maine's NPDES Phase II program establishes permitting requirements for construction sites disturbing more than one acre, certain industrial activities, and Municipal Separate Storm Sewer Systems (MS4s) in designated urbanized areas. Under this program, the MEDEP issued a General Permit for the Discharge of Stormwater on July 1, 2008 that requires MS4s to meet the applicable provisions of Maine's waste discharge and water classification classes and rules. All four of the municipalities in the Long Creek Watershed (South Portland, Westbrook, Scarborough and Portland) along with the Maine Department of Transportation (MaineDOT) and Maine Turnpike Authority (MTA) are subject to General Permit stormwater regulations in designated urbanized areas. (These urbanized areas include only a small portion of property owned or controlled by South Portland and Portland in the Long Creek watershed. To comply with the MS4 general permit, MS4 municipalities must develop stormwater program management plans that address the following six minimum control measures in their designated urban areas:

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.

These stormwater program management plans identify measures that municipalities are expected to include in conjunction with their MS4 plans. In 2002, an "Interlocal Stormwater Workgroup" (ISWG) was formed to help facilitate and coordinate stormwater management efforts among the regulated MS4 municipalities in the Greater Portland region, which includes the Long Creek watershed. The ISWG group completed a Stormwater Program Management Plan template for individual MS4 members to use that will comply with the six minimum control measures.

Landowners with parcels in the Long Creek watershed with one acre or more of IC are also expected to be required in 2009 to obtain a Maine Pollutant Discharge Elimination System (MEPDES) permit (e.g., an individual or general permit), unless their property is already covered by an MEPDES permit for either an industrial or MS4 stormwater discharge. MEDEP, the municipalities and other Project Partners agree that the Long Creek Watershed Management Plan can provide an alternative to obtaining an individual MEPDES permit to meet these new permit obligations. By developing this alternative path, the Project has provided municipalities and other landowners the opportunity to participate in a coordinated, cooperative effort that is expected to be more environmentally effective for Long Creek and less expensive for individual landowners. The Project hopes that this approach will be effective in Long Creek and provide a useful model for restoration of other impaired streams in Maine communities.

South Portland and Portland have property in the watershed that is subject to MS4 permit requirements and other watershed property that is subject to the new MEPDES permit requirements. Similarly, a few large industrial facilities include property that is covered in part by an industrial discharge permit, but for the remainder will be subject to the new MEPDES permitting requirements. MEDEP will explore ways to streamline administrative burdens on those entities that will have land be covered by different permits, and to bring the different permits into alignment.

Maine also has stormwater management laws (Chapters 500 and 502) that require development projects exceeding certain threshold criteria to include measures for the treatment of stormwater pollutants, protection of stream channels from erosion, mitigation of potential temperature impacts, and flood control. Chapter 500 requires additional stormwater controls in urban watersheds of impaired streams (such as Long Creek) to address the potential for further degradation of stream water quality resulting from an increase in IC from new development. Chapter 500 has identified specific best management practices (BMPs) and design criteria that must be employed to provide required stormwater treatment.

2. Watershed Characterization

2.1 Subwatersheds

Long Creek (formerly known as Jackson Brook) is a freshwater stream in southern coastal Maine which flows into Clarks Pond, a small, relatively shallow impoundment eventually draining into the Fore River and Casco Bay. Long Creek consists of a main stem and five tributaries. The **main branch** of Long Creek is approximately 3.84 miles long and is intersected by a **south branch** (~1.76 miles), **Blanchette Brook**—also referred to as the main branch northern tributary (~1.53 miles), a **north branch** (~1.39 miles), an **eastern branch** (~0.91 miles) and a **main branch western tributary** (~0.49 miles). In total, there are nearly 10 miles of streams in the Long Creek watershed (Figure 2a).

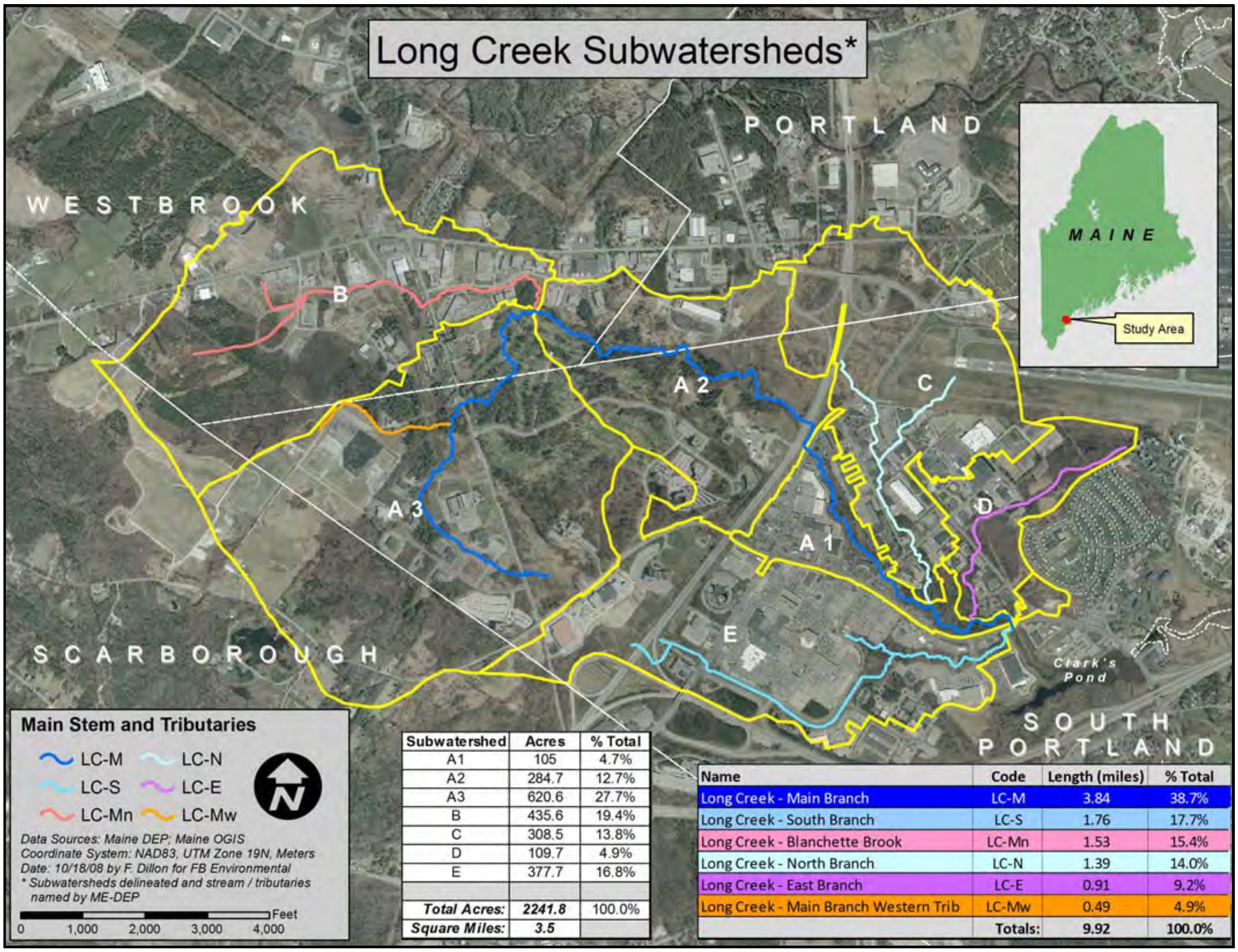


Figure 2a: *Long Creek subwatersheds.*

The MEDEP subdivided the Long Creek watershed into seven subwatersheds based on the drainage areas for particular stream segments and tributaries (Figure 2a). They are as follows:

- **Subwatershed A1** consists of approximately 105 acres and drains the area of Long Creek's Main Branch bounded by Maine Mall Road, Foden Road, and the rear boundaries of the parcels along the western side of Darling Avenue.

- **Subwatershed A2** consists of approximately 285 acres and drains the area of Long Creek's Main Branch from the confluence of Blanchette Brook down to the northwestern side of Maine Mall Road.
- **Subwatershed A3** consists of approximately 621 acres and drains the area along Long Creek's Main Branch above the confluence with Blanchette Brook.
- **Subwatershed B** consists of approximately 436 acres and drains into Blanchette Brook.
- **Subwatershed C** consists of approximately 309 acres and drains Long Creek's North Branch
- **Subwatershed D** consists of approximately 110 acres and drains into Long Creek's East Branch
- **Subwatershed E** consists of approximately 378 acres and drains into Long Creek's West Branch.

The total land area of the Long Creek watershed is approximately 3.5 square miles and it is located primarily in South Portland (62% of watershed area) and also drains portions of Westbrook (21%), Scarborough (11%), and Portland (6%) in Cumberland County (Figure 2b).

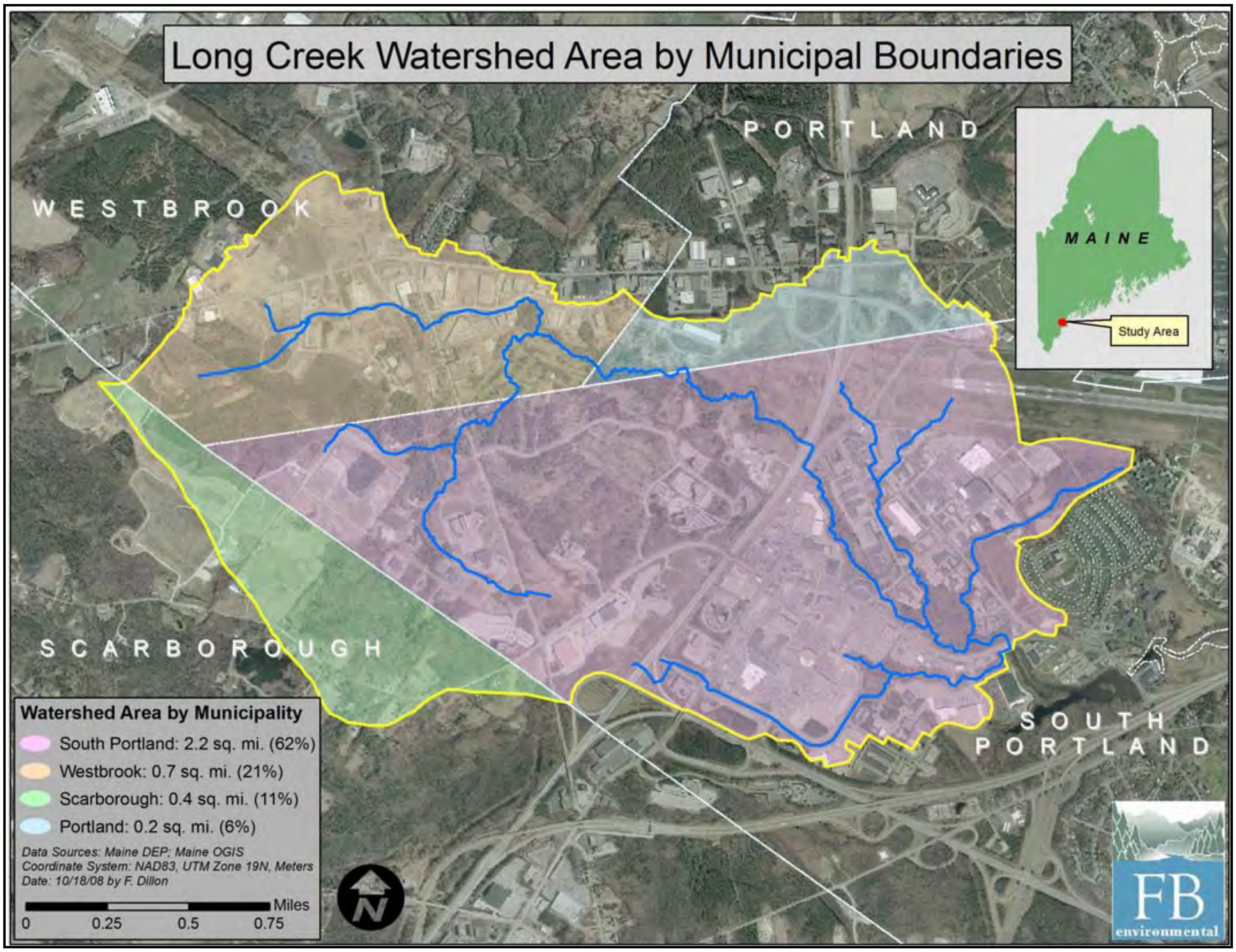


Figure 2b: *Watershed areas by municipal boundaries.*

2.2 Climate

The Long Creek region has an average monthly temperature of 45.7° F (NOAA, 2008). Historically, the number of days with a maximum temperature of 90° F or greater is 4.5 days per year while an average of 154.7 days per year experience a minimum temperature of 32° F or lower. Daily precipitation values are an important consideration in determining the extent of stormwater runoff that can be treated by a particular restoration practice. For the period between 1940 and 2008, the average annual precipitation for this area is 45.83 inches and snowfall averages 66.4 inches per year. Historically, there are 128 days per year with 0.01 inches or more of rainfall; 77 days per year with 0.10 inches or more of rainfall; 29 days per year with 0.50 inches or more of rainfall; and 11 days with 1 inch or more rainfall (Table 2a).

Table 2a: *Long Creek watershed daily precipitation ranges from 1940-2008 (NOAA, 2008).*

Precipitation Ranges	Number of Days	% Total for all Days	% Total for Days with Precip
No precip	12328	49.8%	-
Trace	3642	14.7%	29.3%
>0" - <0.1"	3473	14.0%	27.9%
0.1" - 0.25"	1880	7.6%	15.1%
>0.25" - 0.5"	1535	6.2%	12.3%
>0.5" - 1"	1242	5.0%	10.0%
>1"	677	2.7%	5.4%
Total Days for Period:	24777	100%	100%
Days with Precip:	12449		

Daily maximum precipitation values for each month range from a low of 3.21 inches in February 1965 to a high of 11.74 inches in October 1996. Average maximum daily precipitation values for each month range from a low of 1.03 inches in January to a high of 1.66 inches in October. Monthly average precipitation rates in southern Maine range from 2.8 inches/year in August to 4.7 inches/year in November (Table 2b). On average, there are 17 days per year with thunderstorms and 47 days per year with heavy fog (defined as visibility of less than one mile).

Table 2b: *Long Creek watershed Monthly precipitation summaries.*

1940-2008	Max Daily Precip (in)	Avg Max Daily Precip (in)	Avg Monthly Precip (in)
Jan	3.56	1.03	3.50
Feb	3.21	1.18	3.33
Mar	3.47	1.27	3.90
Apr	5.21	1.42	3.94
May	3.41	1.13	3.65
Jun	4.03	1.18	3.34
Jul	3.37	1.05	3.03
Aug	7.75	1.12	2.80
Sep	7.49	1.35	3.23
Oct	11.74	1.66	4.00
Nov	4.7	1.55	4.69
Dec	3.5	1.33	4.12

2.3 Soils and Surficial Geology

> **Infiltration rate** is a measure of the rate at which soil is able to absorb rainfall. It is measured in inches per hour or millimeters per hour. The rate decreases as the soil becomes saturated. If the precipitation rate exceeds the infiltration rate, runoff will usually occur unless there is some physical barrier.

Long Creek is generally low-gradient and, in most locations, has a streambed dominated by fine sediment size classes (i.e., sands, silts, and clays). The general soils of the watershed include the Scantic, Lamoine, Buxton and Lyman series. Many of the soils in the Long Creek Watershed are classified as poorly drained (Figure 2c). This indicates that slow ***infiltration rates*** may be a limiting factor for stormwater treatment practices in many areas of the watershed.

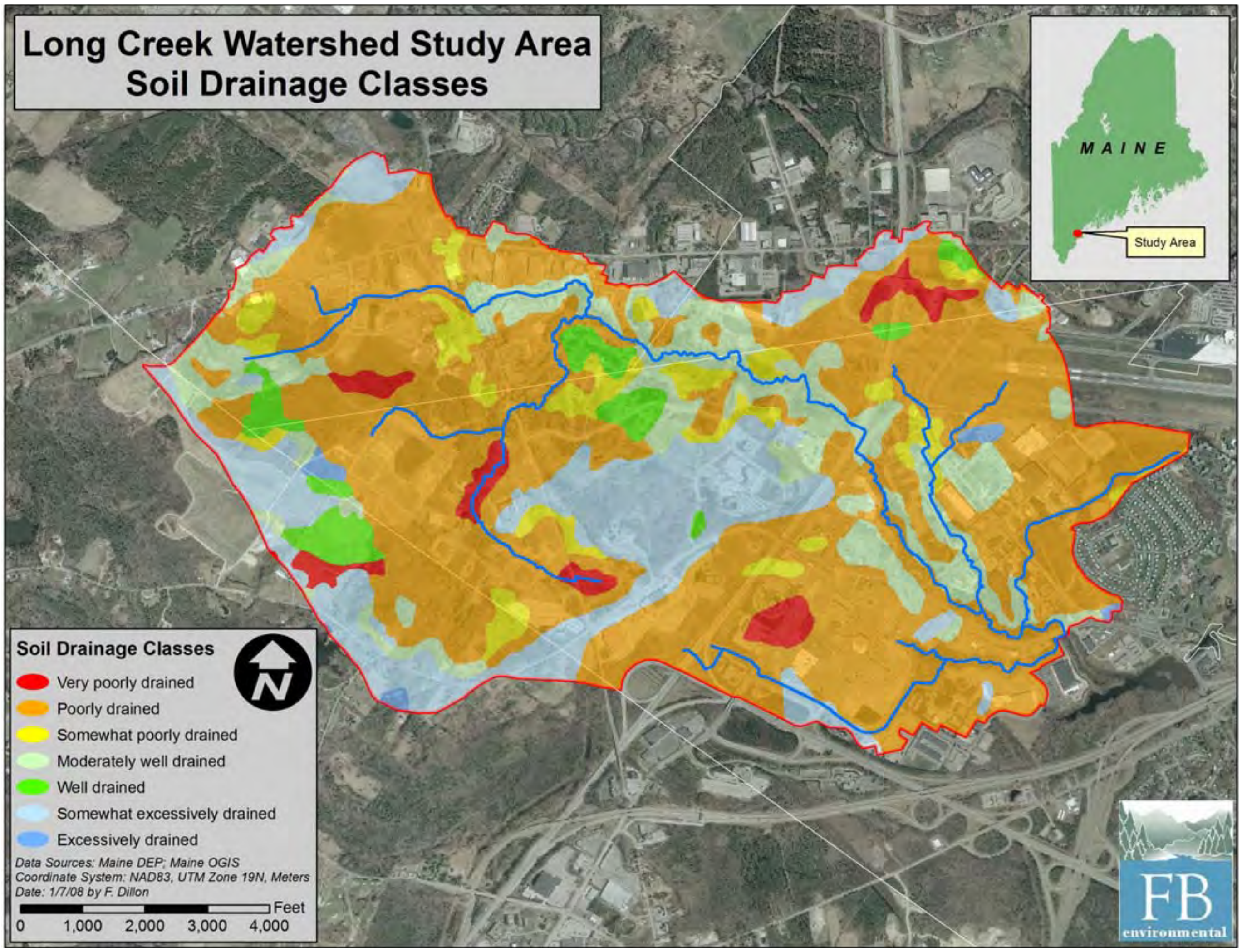


***Figure 2c:** Soil drainage classes in the Long Creek Watershed.*

The surficial geology of the Long Creek watershed is dominated by the Presumpscot Formation, a glaciomarine drift composed of clay with sandy intervals deposited in shoreline areas. Some glacial till is found in the watershed, but is generally not found along the stream itself (Figure 2d, p. 9). The stream substrate consists of sand, silt, and clay with larger rock present only where artificial bank armoring has fallen into the channel or there is a very occasional outcrop of ledge. For most of its length, the stream has created small valleys carved into the underlying glacially deposited materials. The lower watershed consists of a level terrace surface up to 23 feet higher than the stream channel. A floodplain abuts the channel where the valley is wider and Long Creek's numerous tributaries spill out onto the floodplain where they are less confined by the valley side slopes (Field, 2006).

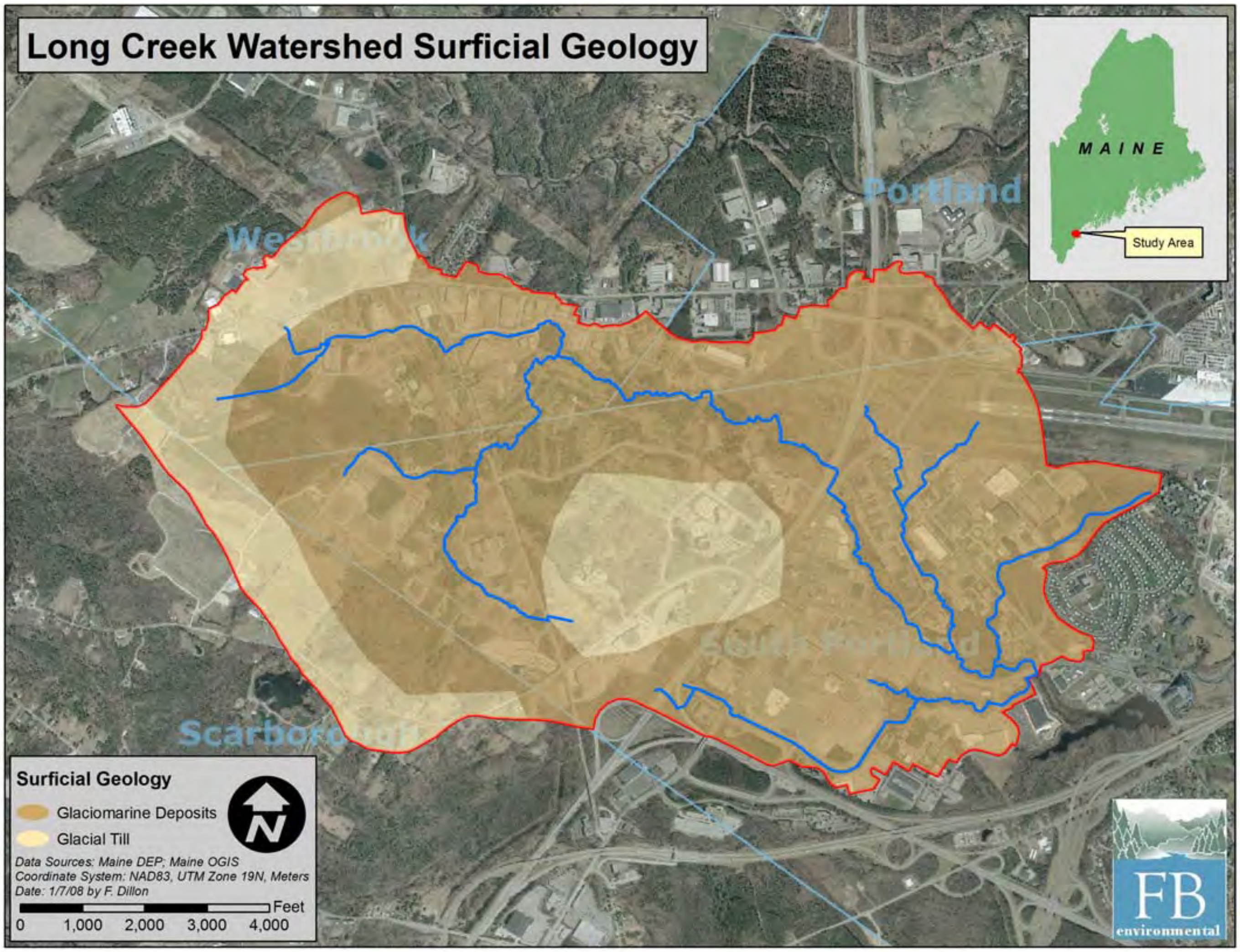


Figure 2d: *Surficial geology in the Long Creek Watershed.*

2.4 Land Use and Growth Trends

Land uses in the Long Creek watershed have changed dramatically in the last 60 years. What was once primarily a rural landscape with forests and fields is now a developed area. Figure 2e (p.10) depicts contrasting views of development in the watershed over a span of 19 years (1976-1995). These photos show a typical pattern of growth moving outwards from the original mall area. Figure 2f (p.10) depicts changes in IC for the most heavily developed area of the watershed over a longer time period from 1940 to 2004.

As of 2004, approximately 38% of the Long Creek watershed consisted of medium to high intensity development with a nearly equal proportion of low intensity development or developed open space (Figure 2g, p.11). These developed areas include numerous shopping malls and associated commercial enterprises, car dealerships, a golf course, several light industrial facilities, office parks, an international jetport, and a landfill / ashfill, among others.

Figure 2e: *Changes in development growth patterns in the Long Creek watershed (Source: MEDEP).*

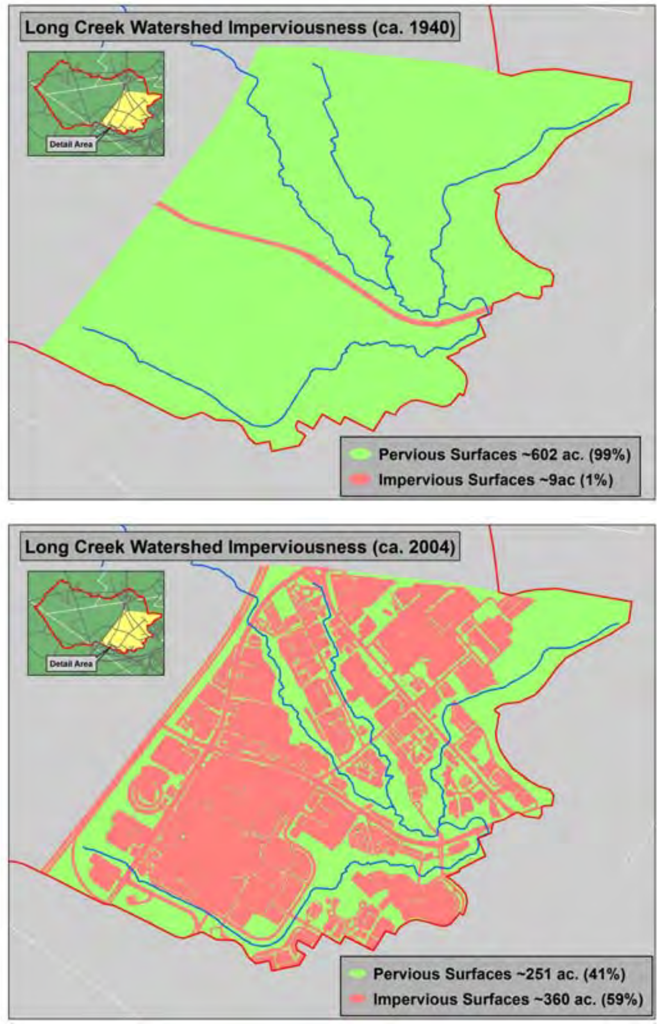


Figure 2f: *IC change in the most developed portion of the Long Creek watershed (Source: MEDEP).*

Due to the prevalence of commercial and industrial uses, the Long Creek Watershed has a very low residential population. However, population growth in many of the surrounding communities has increased steadily in the last 40 years and has impacted commercial growth and the transportation system in the Long Creek Watershed. From 1960 – 2000 the population in Cumberland County increased by over 45% from approximately 182,000 to approximately 265,000 residents. During this same period, South Portland's population increase was much more modest at approximately 2% from 22,788 to 23,324 residents. By contrast, the population in nearby communities using the Long Creek watershed as a commercial and retail service center increased considerably. For example, Scarborough's population increased by 164% (6,418 to 16,970) while Gorham increased by 145% (5,767 to 14,141 residents).

Figure 2h (p.12) displays the growth rates of Long Creek area communities (within approximately 10 miles of the watershed). This graphic indicates a few trends in the last 40 years:

- Population in the nearby urban center, Portland, dropped off considerably and then rebounded slightly
- Population in South Portland has remained nearly stable.

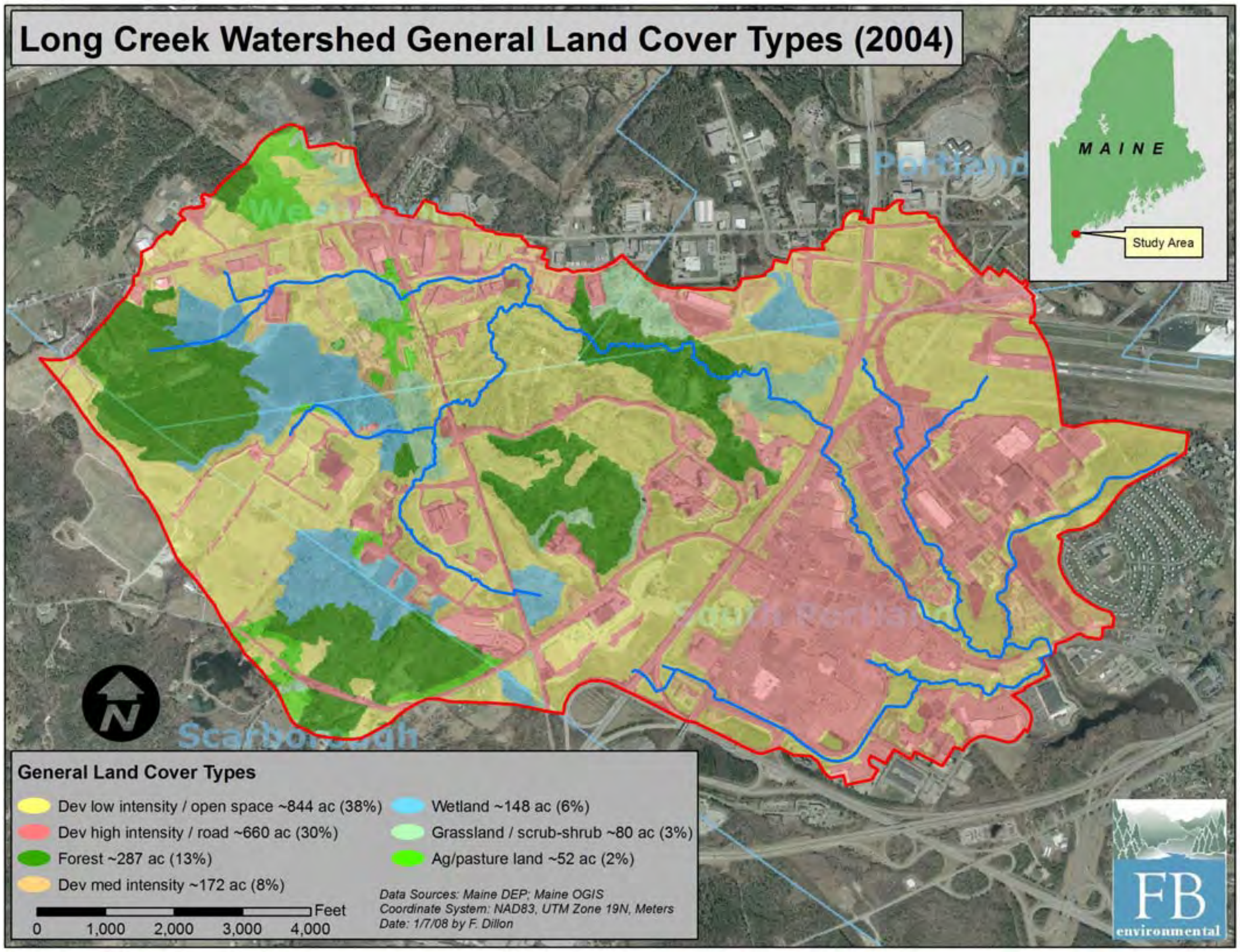


Figure 2g: *General land cover types in the Long Creek watershed (2004).*

- Population in the surrounding suburban areas (Scarborough, Gorham, Falmouth, Cape Elizabeth) has increased steadily.

A look at the more recent trends indicates that of the four watershed communities, only Scarborough has experienced significant growth compared to communities below.

- South Portland 23,324 (2000 Census) 0.7% increase since 1990;
- Westbrook 16,142 (2000) 0.13% increase since 1990;
- Scarborough 16,970 (2000) 35.6% increase since 1990;
- Portland 64,249 (2000) 0.17% decrease since 1990.

2.5 Sanitary and Stormwater Infrastructure

Sanitary sewers and stormwater drains exist in three of the four communities in the Long Creek watershed – South Portland, Westbrook and Portland. The area of Scarborough residing in the watershed does not have any publicly owned piped infrastructure, though it does convey stormwater via a system of roadside ditches and culverts. All of the sanitary and stormwater systems in the South Portland, Westbrook and Portland portions of the watershed are separate so that stormwater is discharged into Long Creek or one of its

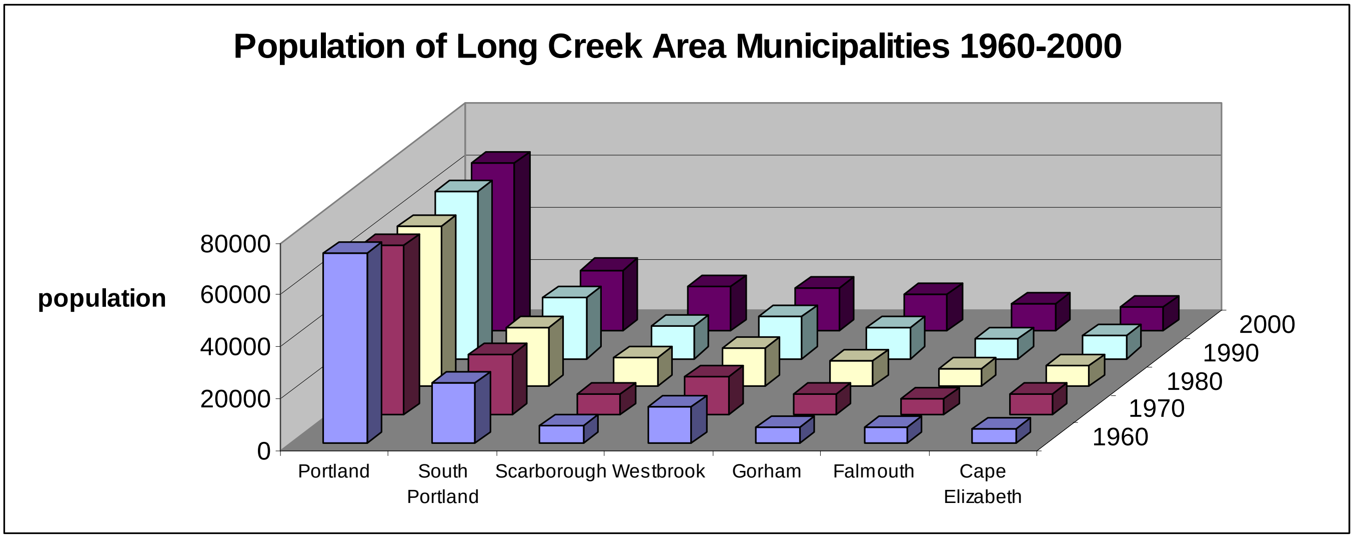


Figure 2h: *Population changes in the Long Creek (1960 – 2000).*

tributaries and sewage is conveyed to the wastewater treatment facilities (in either South Portland or Portland). The vast majority of flow to the stormwater system from these developed areas originates from IC.

2.6 Transportation Infrastructure

The commercial activities in the Long Creek watershed are a significant source of revenue and employment for the region as a whole and for the City of South Portland in particular, which is host to the state's largest retail center. They are also a significant source of traffic. Daily vehicle counts for the year 2000 were estimated at 38,000 on the Maine Mall Road corridor (up from approximately 30,000 in 1987). Watershed development has continued since then, and traffic on other nearby transportation corridors has increased correspondingly. Transportation infrastructure is an important consideration from a watershed restoration perspective since it comprises such a substantial portion of the overall IC.

The roadway network in Long Creek Watershed is varied both in terms of ownership and maintenance responsibility (Figure 2i, p.13). (Please note that mileage numbers in this paragraph are subject to verification from MaineDOT and MTA). State highways owned by the Maine Department of Transportation (MaineDOT) but mostly maintained by the municipalities comprise the majority of roads in the watershed at approximately 11.6 miles. Municipally owned and maintained townways comprise approximately 4.9 miles of watershed roadways. The Maine Turnpike, a toll highway, divides the central-eastern portion of the watershed with approximately 4.8 miles of paved road and is owned and maintained by the Maine Turnpike Authority (MTA). Associated turnpike exit/entrance ramps also occur in the northern and southern sections of the watershed. A small section of the Turnpike spur, a state highway owned and maintained by the MaineDOT, is located in the southeastern portion of the watershed. State aid roads, which are owned by MaineDOT but maintained by municipalities, extend for about 3.1 miles throughout the watershed. There are also numerous privately owned roadways in the watershed, which are not yet readily available in digital form and so were not measured for this analysis. Finally, extensive areas of paved parking lots are distributed throughout the watershed. Recommendations for addressing some of the pollutants associated with transportation infrastructure can be found in Section 5.

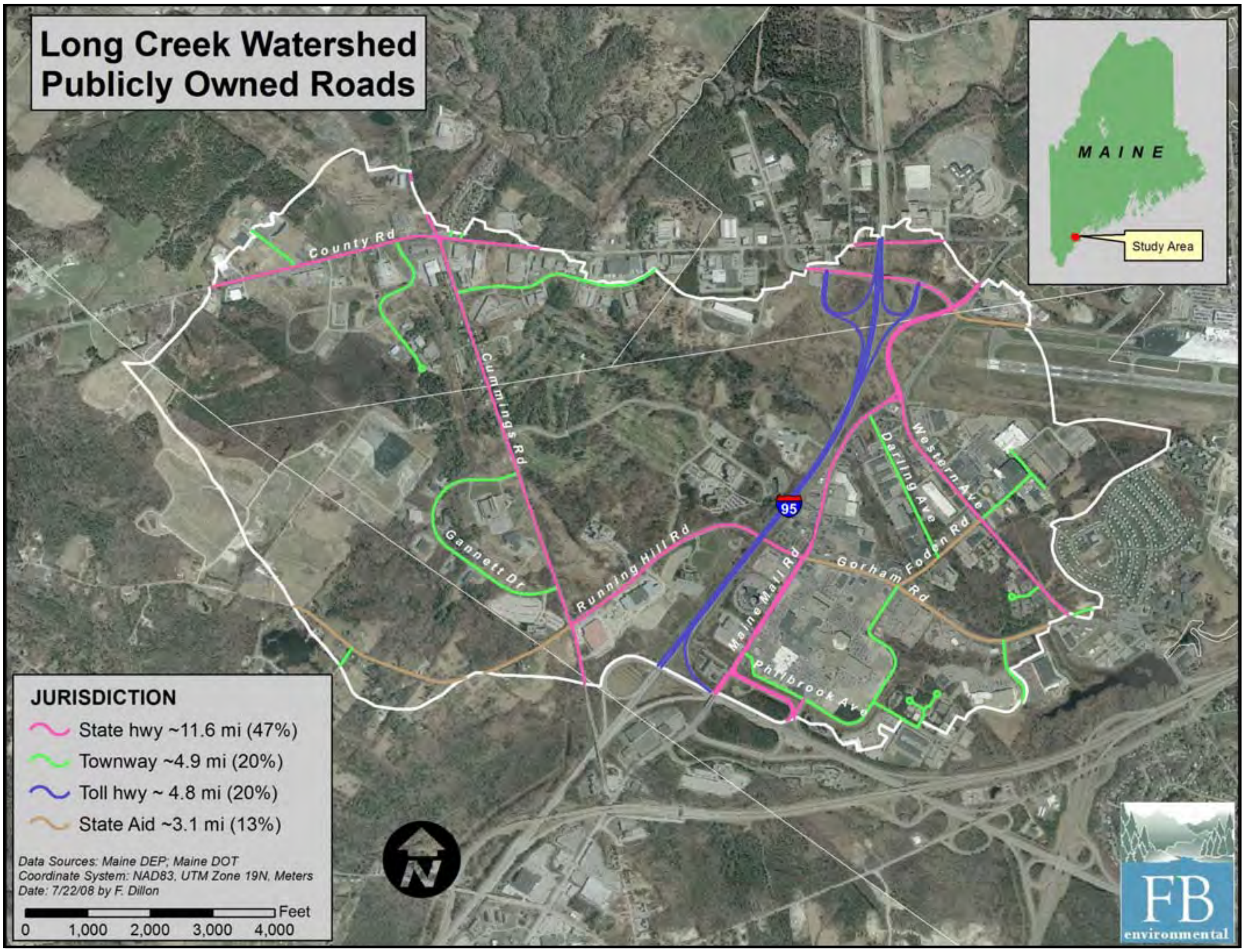


Figure 2i: *Publicly owned roads in the Long Creek Watershed. (Mileage numbers are subject to verification from MaineDOT and MTA).*

3. Causes of Impairment in Long Creek

The causes of impairment in Long Creek have been investigated and well documented, primarily by the following two reports:

- *A Biological, Physical, and Chemical Assessment of Two Urban Streams in Southern Maine: Long Creek & Red Brook*. MEDEP 2002.
- *Causal Analysis of Biological Impairment in Long Creek: A Sandy-Bottomed Stream in Coastal Southern Maine*. USEPA 2007.

Each of these reports is available for review and download at the Restore Long Creek website (www.restorelongcreek.org). As discussed previously, the adverse impacts of development activities have been identified as the causes of impairment in Long Creek. These causes and their effects on the aquatic health of Long Creek are described in detail below.

3.1 Impacts of Development: Impervious Cover Assessment

As noted previously, impervious cover (IC) is defined as land surface areas that do not allow water to infiltrate into the ground. Impervious cover typically includes paved areas, such as parking lots, roadways, sidewalks and rooftops. Percent IC of a contributing watershed is a measure of development activity and expected adverse impacts to stream aquatic health. The impervious cover model relates a stream's health (i.e., state of impairment) to the percentage of impervious cover in its contributing watershed. The model was developed by compiling and evaluating extensive data relating watershed percent IC to hydrologic, physical, water quality, and biological conditions of aquatic systems (CWP, 2003).

The Center for Watershed Protection and other investigators have identified strong correlations between increasing percent IC and decreasing aquatic health in small urban watersheds. Aquatic health has been adversely impacted in these investigations by a variety of factors including:

- Increased runoff volumes;
- Increased channel incision and other adverse physical modifications;
- Increased sediment loads;
- Increased pollutant loads;
- Reduced aquatic habitat quality; and
- Reduced biological (e.g., macroinvertebrate and fish) populations and diversity.

Through the evaluation of hundreds of small urban watersheds, investigators have been able to establish a quantitative relationship between percent IC in a watershed and its overall aquatic health. This relationship is shown schematically in Figure 3a (p.15). While this research is only a general guide since actual impacts can vary considerably depending on a number of factors (e.g., landuse type, extent of directly connected IC, etc.), it indicates that at approximately 10% IC streams tend to become impacted and at approximately 25% IC streams tend to become non-supporting of healthy aquatic communities (CWP, 2003).

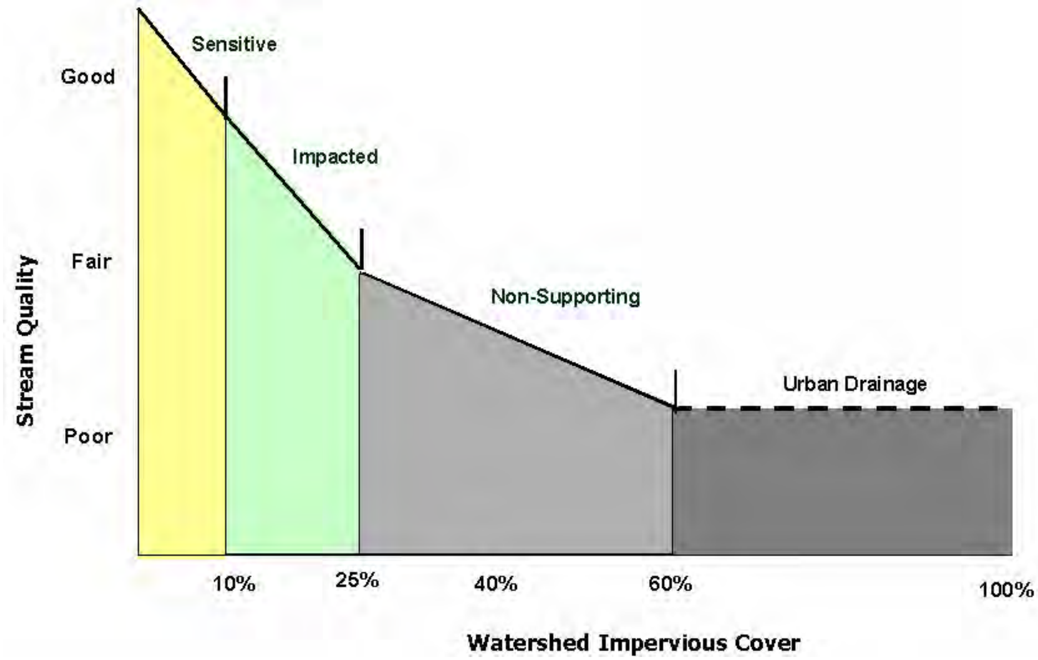
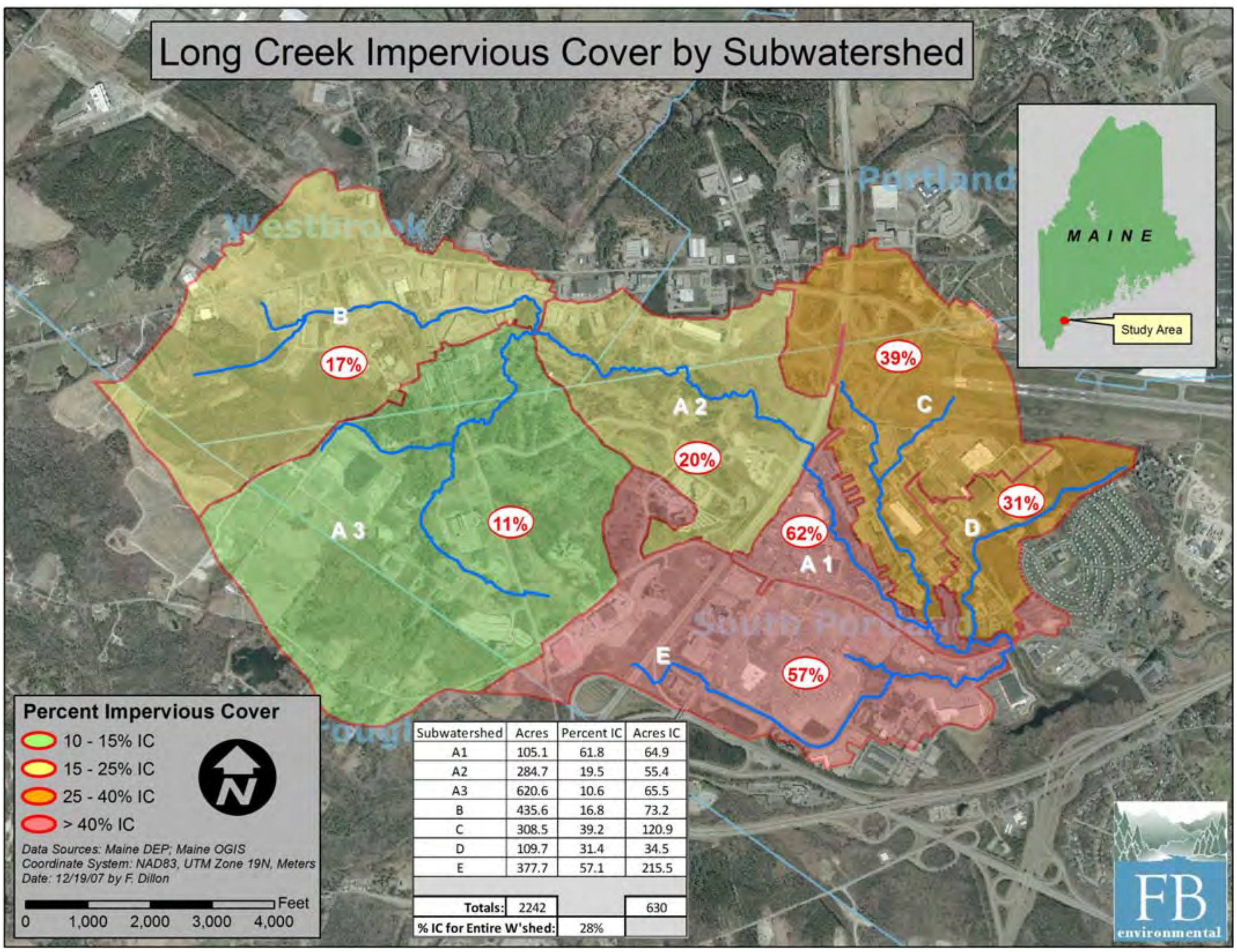


Figure 3a: *Relationship of impervious cover to stream habitat quality.*



Subwatershed	Acres	Percent IC	Acres IC
A1	105.1	61.8	64.9
A2	284.7	19.5	55.4
A3	620.6	10.6	65.5
B	435.6	16.8	73.2
C	308.5	39.2	120.9
D	109.7	31.4	34.5
E	377.7	57.1	215.5
Totals:	2242		630
% IC for Entire W'shed:	28%		

Figure 3b: *Impervious cover by subwatershed*

Impervious Cover in Long Creek

The percent of land covered by impervious surfaces in the watershed is very high at approximately 28% overall. Percent IC is shown by subwatershed area in Figure 3b (p.15) and exceeds 60% in some areas. Appendix 1 provides a more detailed summary by MEDEP of impervious cover types in the Long Creek watershed. In 2002, MEDEP completed a study of the Long Creek watershed and nearby Red Brook watershed. Red Brook is relatively undeveloped and has percent IC of less than 10%. It was included as a relatively "clean" basis for comparison with Long Creek since aquatic conditions in both streams would be expected to be very similar, if Long Creek were not highly developed.

Watershed measurements were collected in both Long Creek and Red Brook including percent IC, stream flow, water quality parameters, and aquatic community status. Long Creek was found to be severely impaired in contrast to Red Brook, which complied with most water quality classification standards. Additionally, the hydrologic response of the two streams to rainfall events is markedly dissimilar, as shown in Figure 3c where flow measured following a storm event for a Long Creek subwatershed with 33% IC was nearly seven times greater than a nearby subwatershed in Red Brook, which had an IC of 6%. Higher extents of IC reduce the amount of water infiltrating into the ground and therefore result in higher stormwater runoff volumes as well as much more rapid increases in peak stream flows. Consequently, watersheds with higher ICs can increase the erosive force of streams during storm events enough to result in adverse impacts to aquatic habitats. In 2007, EPA conducted an investigation of Long Creek that further confirmed impervious cover as a primary cause of impairment.

3.2

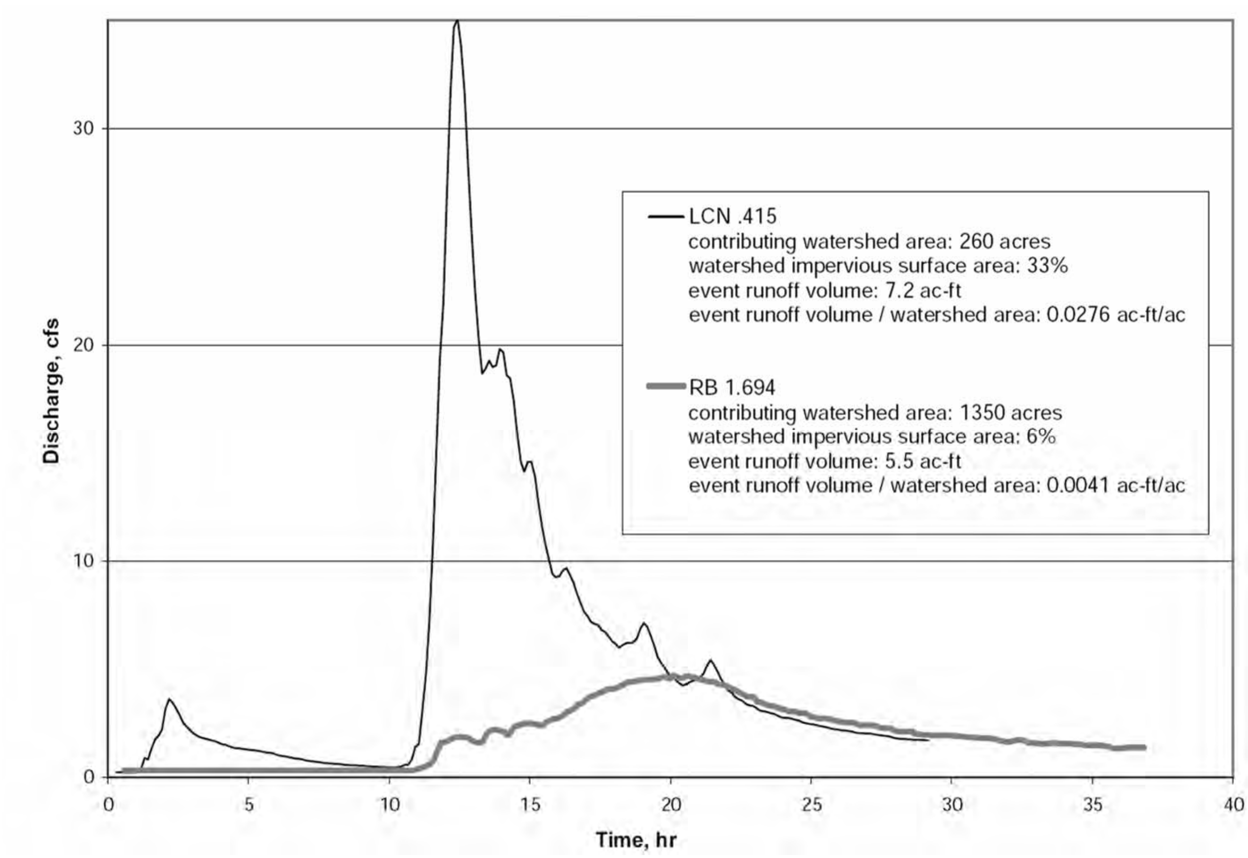


Figure 3c: *Storm hydrographs on Long Creek and Red Brook (control), September 25, 2001.*

Applicable Water Quality Standards and Criteria

Water quality standards and criteria are measures of aquatic health and provide thresholds that are applied in evaluating surface waters. Water quality classification standards of all surface waters in the State of Maine have been established by the Maine Legislature (Title 38 MRSA 464-468). MEDEP and other entities conduct monitoring of water quality and aquatic life to determine whether a stream is meeting its designated uses. The state has classified some segments of Long Creek as Class B and other segments as Class C, as shown in Figure 3d. Classifications were assigned in the 1970's based on town boundaries and predominant surrounding land uses. Class B standards are more stringent than Class C standards. MEDEP has documented numerous violations of stream classification standards in the freshwater portion of Long Creek and its tributaries. These measurements have resulted in Long Creek and its tributaries being listed as an impaired stream. A summary of applicable water quality standards and criteria for Long Creek is provided below followed by a summary of field assessments of Long Creek.

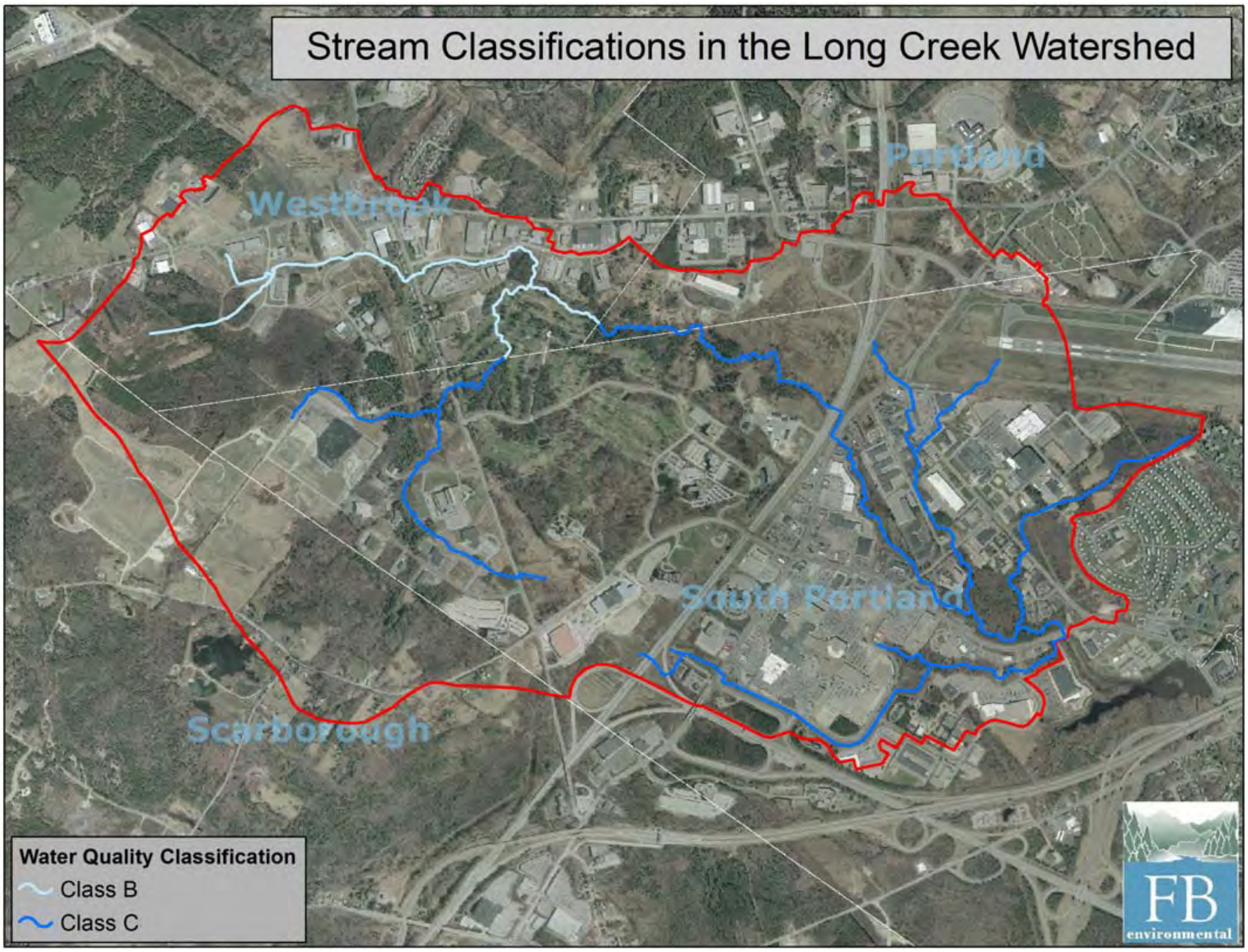


Figure 3d: *Stream classifications for Long Creek watershed.*

3.2.1 Overview of Applicable Water Quality Standards and Criteria

The designated uses and water quality standards and criteria associated with Maine Class B and Class C waterbodies are listed in Table 3a, below.

Table 3a: *Maine water quality standards and criteria for Class B and C waterbodies*

Class B Surface Waters
Designated Uses: Drinking water supply, recreation in and on the water, fishing, industrial process and cooling water supply, hydroelectric power generation, navigation, and an unimpaired habitat for fish and other aquatic life.
Numeric Criteria
Dissolved oxygen: >7 ppm and >75% saturation
Statewide water quality criteria (SWQC): Chronic and maximum allowable instream values for specified toxic pollutants designated to protect uses specified in the Water Classification Program. Includes metals identified in stormwater, such as Cadmium, Chromium, Copper, Lead, and Zinc.
Bacteria (E.coli): <64/100ml geometric mean and <236/100ml instantaneous value (May 15th – Sept. 30th).
Narrative Criteria
Habitat: Habitat for fish and other aquatic life shall be unimpaired.
Discharges: Shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.

Class C Surface Waters
Designated Uses: Drinking water supply, recreation in and on the water, fishing, industrial process and cooling water supply, hydroelectric power generation, navigation, and habitat for fish and other aquatic life.
Numeric Criteria
Dissolved oxygen: >5 ppm and >60% saturation
Statewide water quality criteria (SWQC): Chronic and maximum allowable instream values for specified toxic pollutants designated to protect uses specified in the Water Classification Program. Includes metals identified in stormwater, such as Cadmium, Chromium, Copper, Lead, and Zinc.
Bacteria (E.coli): <126/100ml geometric mean and <236/100ml instantaneous value (May 15th – Sept. 30th).
Narrative Criteria
Habitat: Habitat for fish and other aquatic life.
Discharges: May cause some changes in aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving water and maintain the structure and function of the resident biological community.

3.2.2 Aquatic Community Assessment Criteria

Assessment of aquatic communities is required for determining compliance with water quality standards and criteria. MEDEP has developed and implemented numeric tiered aquatic life criteria to support interpretation of long-standing narrative criteria. The MEDEP aquatic life criteria program uses macroinvertebrate sampling and associated community structure modeling to provide a consistent and technically robust protocol for assessing aquatic life. Maine's criteria are based on 20 years of data, from (currently) 768 river and stream and 126 wetland sampling locations, and over 1,300 individual sampling events. Through the protocol, aquatic biological sampling results from a subject stream are compared to the criteria established for each surface water classification to determine whether aquatic life criteria are met. These criteria rely primarily on the relative abundance and diversity of aquatic organisms that serve as key indicators of overall water quality.

Macroinvertebrate community - Macroinvertebrates are aquatic organisms that provide accepted measures of longer term water quality conditions because they are subjected to potential pollutants over extended time periods. The macroinvertebrate community is sampled by deploying rock bags on the stream bottom and collecting the organisms that colonize the bags. The collected organisms are identified and quantified and the resulting data is used to calculate 25 variables that are applied to linear discriminant models which predict the probability that the community will meet the aquatic life criteria for a given stream classification (A, B, or C). The criteria are defined in Chapter 579 "Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams".

Brook Trout - The aquatic life criteria defined in 38 MRSA Section 465 require that indigenous fish species be supported for all stream classes. Brook trout are considered indigenous to all flowing Maine streams and Long Creek is known to have been a fishery for brook trout prior to the accelerated development of the area. The less developed portions of adjacent Red Brook support a very healthy brook trout population.

3.3 Water Quality and Biological Assessments

In 2002 and 2004, the MEDEP completed an assessment of Long Creek that identified instances and locations in the watershed where water quality and aquatic life standards were not met (Figure 3e, p. 20). The nearby Red Brook watershed was also assessed and served as a reference stream (to compare with the conditions in Long Creek) in the 2002 MEDEP study. This study generally concluded that the types of impairments affecting the biological community were multiple and diverse and primarily linked to the adverse impact of impervious surfaces. In 2007, the US EPA applied the findings from the MEDEP's 2002 study to a causal analysis that identified multiple probable causes of biological impairment. Each of these studies is summarized below. Additionally, a detailed MEDEP summary of violations of water quality classification standards for Long Creek and its tributaries is provided in Appendix 2.

3.3.1 Dissolved Oxygen

As part of the water quality monitoring conducted for the 2002 MEDEP Long Creek report, dissolved oxygen (DO) was measured on several occasions and at several sample site locations throughout the Long Creek watershed. Depleted DO levels were measured at various times of the year and often did not meet applicable Class B and Class C water quality standards. In some cases, low DO readings occurred at sites with little or no shading due to inadequate shoreline vegetation. In all cases, water quality classification violations for DO were associated with slow-moving stream segments that exhibited little turbulence and contained few significant pieces of large woody debris (both of which reintroduce oxygen into surface waters). The US EPA's 2007 Long Creek report also identified low DO and altered flow regimes as adversely impacting aquatic biota.

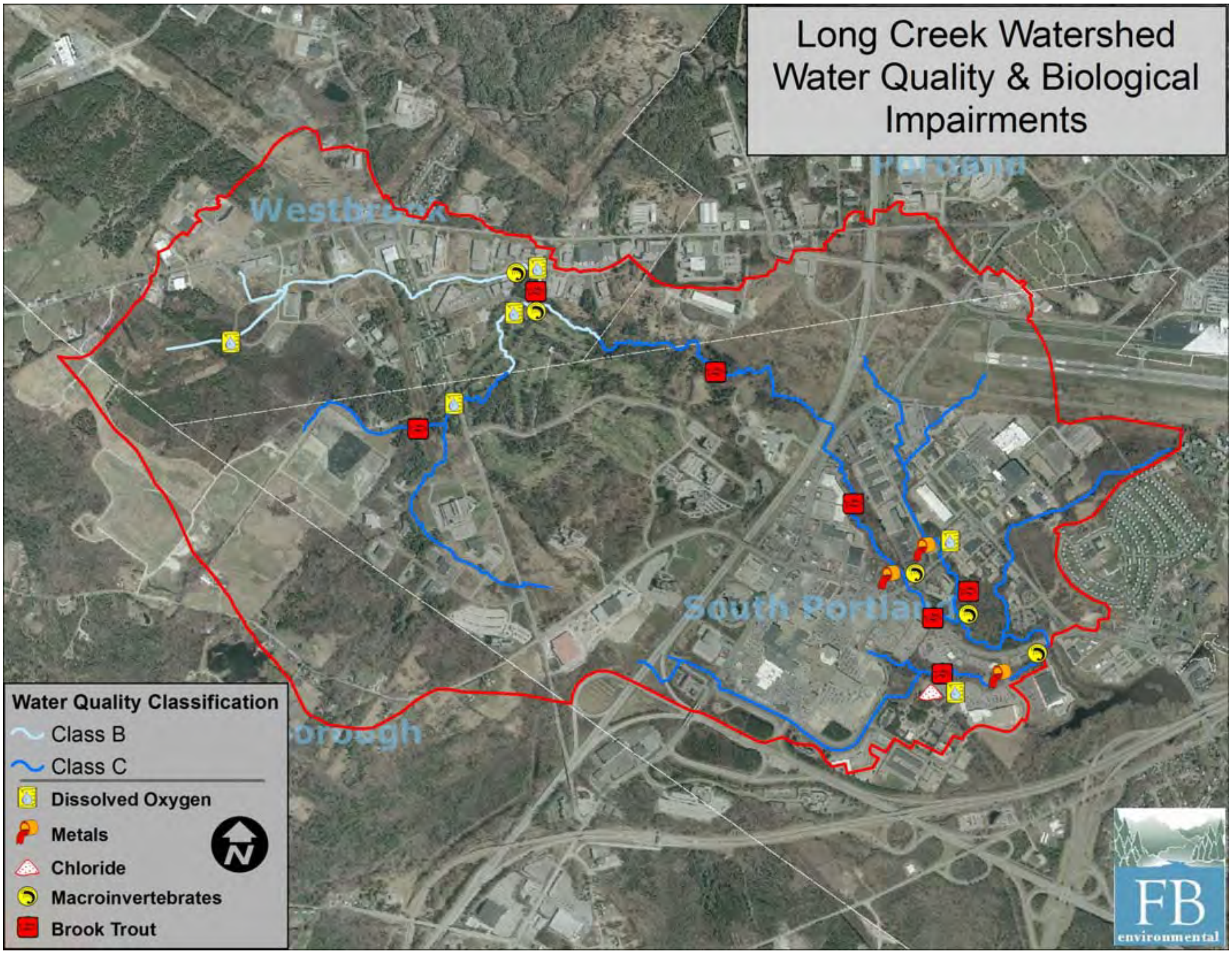


Figure 3e: *Locations of water quality and biological impairments in the Long Creek watershed (Source: MEDEP)*

3.3.2 Metals, Chloride and Other Pollutants

Increased concentrations of heavy metals in aquatic habitats are typically associated with nearby urbanization. Chronic exposure to metals contamination can result in reduced abundances, loss of sensitive species and reduction of diversity of aquatic organisms (MEDEP, 2002). Heavy metal samples (lead, copper, cadmium, nickel, and zinc) were collected for the MEDEP's 2002 study during three storm events at three sample site locations and on three occasions during extended periods of dry weather at six sample site locations (as well as at reference sites along Red Brook). No violations of water quality classification criteria occurred for the dry weather samples, while all three storm sample sites experienced water quality classification violations during each storm event. The 2007 US EPA report found that episodic toxicity from metals during storm events may be contributing to impairments at some Long Creek sites.

As with metals, chronic exposure to elevated chloride levels can adversely impact the growth and reproduction of aquatic organisms. Like metals, chloride concentrations are also often elevated in urban streams (due to the application of road salt for deicing during winter months). Chloride samples were collected at the same times and locations throughout the watershed as the metals samples. During storm conditions, the chloride concentrations were generally much higher than the control samples collected nearby from the Red Brook watershed. Similarly, this pattern existed during dry weather conditions. There was an exceedance of water quality classification standards at one site on 2 separate dates.

A variety of polycyclic aromatic hydrocarbons (PAHs) were also detected at three Long Creek monitoring stations during storm event sampling, but not detected at the Red Brook monitoring station. PAHs are a class of organic compounds originating from various industrial applications, the incomplete combustion or leakage of gasoline and certain kinds pavement sealants. While aquatic life criteria are not well established for PAHs, these pollutants are generally considered to be harmful to aquatic (and human) life.

3.3.3 Biological Assessment

A Biological, Physical, and Chemical Assessment of Two Urban Streams in Southern Maine: Long Creek & Red Brook, the MEDEP's 2002 watershed assessment report, identifies adverse impacts on the aquatic biota in Long Creek and its tributaries. These include:

- Degraded water quality
- Increased temperatures
- Altered stream flow patterns during storm events and during extended periods of dry weather
- Reduced or degraded stream side habitat (sparse vegetation and poor shading)
- Reduced in-stream habitat quality and diversity (scarcity of large woody material)
- Destabilized stream geomorphology (adverse impacts to stream structure and function due to urbanization / development)

Consequently, many stream segments failed to meet applicable water quality classification standards for aquatic life. MEDEP macroinvertebrate sampling results from the 2002 study indicate that two Long Creek stations in Westbrook failed to meet their statutory designation of Class B, while one station in the Class C section of South Portland failed to meet its designated standards. MEDEP macroinvertebrate monitoring in 2004 also indicated a failure to meet standards for two additional Class C sites in South Portland. While Long Creek was once known to support a trout fishery, MEDEP assessments determined that brook trout were nonexistent at several locations throughout the watershed (and were relatively abundant in the adjacent Red Brook watershed). Absence of brook trout is therefore deemed a violation of aquatic life use criteria for all the stream classes, including Long Creek because of its history as a brook trout fishery. The stream was evaluated at a number of sites and failed to yield brook trout at any of the sites sampled.

In 2007, the US EPA used the assessment results from the MEDEP's 2002 study for a site-by-site causal analysis of impairments in the Long Creek watershed (USEPA 2007) The project team applied biological and water quality monitoring data to the EPA's Stressor Identification process to identify the most probable causes of impairment. The findings from this study are consistent with MEDEP's conclusions that multiple adverse impacts are responsible for the failure of Long Creek and its tributaries to meet water quality classification standards. These impacts include:

- Decreased dissolved oxygen
- Altered flow regime
- Decreased large woody material

- Increased temperature
- Increased ionic strength (most likely from salt application in the winter for pavement de-icing)

The 2002 MEDEP and 2007 US EPA Long Creek reports provide detailed discussions of the monitoring results, assessment methods, and probable causes of impairment in the watershed. The cause of impairment in Long Creek and its tributaries is clearly the adverse impact of intensive development, as exemplified by the percent impervious cover and riparian vegetation clearing practices in the contributing watershed.

3.4 Geomorphic, Riparian and In-Stream Habitat Assessments

In 2004 and 2005, ***fluvial geomorphic*** assessments were completed for Long Creek and its tributaries to determine the impact of urbanization on channel conditions and to prioritize sites for restoration of habitat and channel stability (Figure 3f). Distinct stream segments were identified and characterized based on the extent of alteration resulting from surrounding land uses. A continuum was established between relatively undisturbed stream segments surrounded by forests and with an abundance of woody material in the stream channel and stream segments with various human land use activities in or near the stream channel. The presence of wood in undisturbed stream segments is important for stream

Fluvial geomorphology studies the interplay between natural processes and human activities in relation to stream channel structure and function. Alterations to watershed conditions result in corresponding changes to the built environment and aquatic habitats.

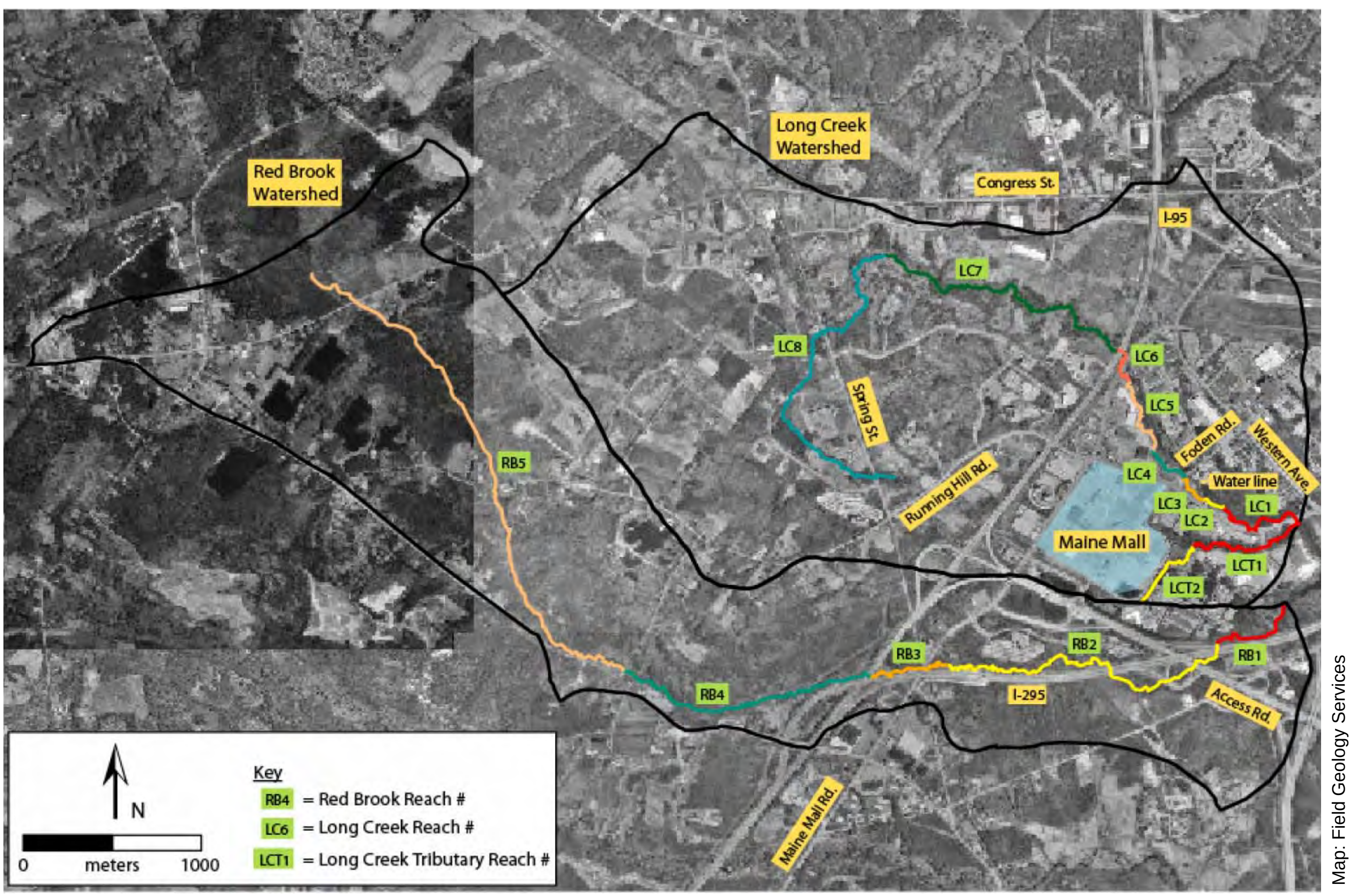


Figure 3f: *Stream reaches for Long Creek and Red Brook geomorphic assessments (Field 2005, 2006). Note that reaches from the 2006 report are not included in this figure.*

channel development since woody material and large individual logs can redirect flow to produce channel sinuosity, induce sediment deposition, and produce overbank flow that creates and maintains side channels across the floodplain. All of these phenomena result in better overall conditions for aquatic organisms.

By contrast, human land use activities in or near the stream channel can adversely alter natural conditions in several distinct ways:

- Stream channel widening and subsequent sediment accumulation due to upstream channel straightening
- Channel down-cutting resulting from constriction of floodplains
- Rapid increases in flow resulting in stream bank erosion and the creation of multiple channels downstream of artificially confined reaches and culverts
- Channel straightening and confinement of channels against high banks of natural deposits or artificial fill from adjacent development

The geomorphic assessments identified where and why these altered stream reaches occurred and developed corresponding prioritized recommendations for restoration. Because most of the development in the Long

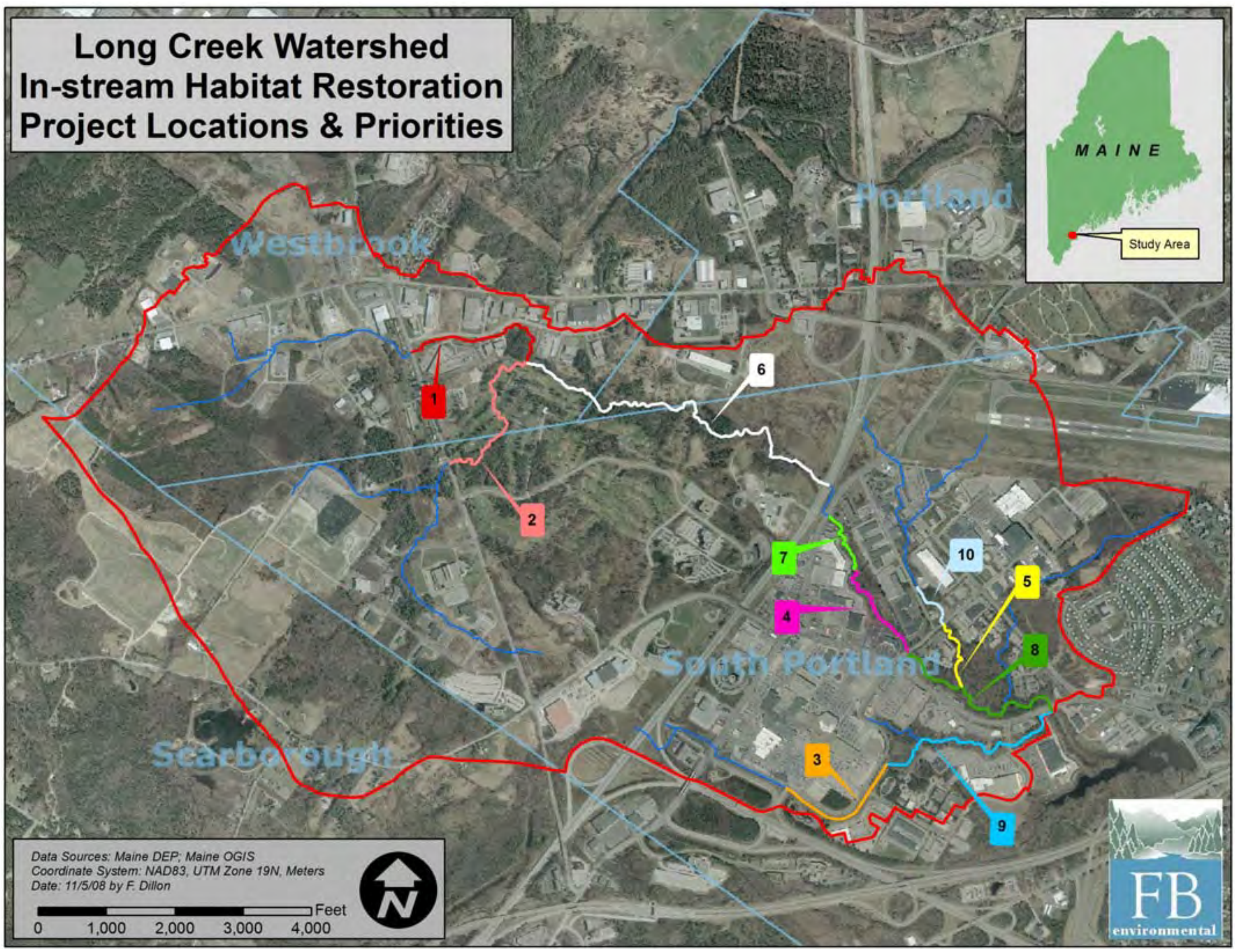


Figure 3g: *MEDEP in-stream habitat restoration locations and priorities*

Creek watershed occurs several meters above the stream channels and forested floodplains, a unique opportunity exists to complete stream restoration projects in highly visible areas without the risk of adjacent property damage. Restoration recommendations generally consist of removing artificial fill that constricts floodplains, re-creating stream meanders along straightened stream segments, and resizing culverts to improve channel stability. All of these will be discussed in detail in section 5.

In conjunction with the geomorphic assessment, the MEDEP also evaluated the riparian areas and in-stream habitat conditions through a combination of existing data report reviews, GIS analyses and field work for most of the streams in the Long Creek Watershed (Figure 3g, p.23). The issues identified supported the findings from the geomorphic assessments and included inadequate vegetated buffer and shading (which likely results in increased stream temperatures); lack of woody material and long-term leaf input (to provide habitat diversity and food sources for aquatic organisms, respectively); and instability of stream banks resulting from adjacent or upstream urban land uses. Appendix 3 provides detailed summaries by MEDEP of riparian, in-stream habitat and geomorphology restoration recommendations. Inclusion of the properties specified in the recommendations of the Plan does not imply agreement by landowners to participate in the Plan. As is discussed in Section 7, landowners will not be asked to decide whether to participate in the program to implement the plan until the end of the "program start up" period, unless external funding sources (e.g., grants) become available and present opportunities to complete projects on a specific landowner's property at lowered or no cost to Plan participants.

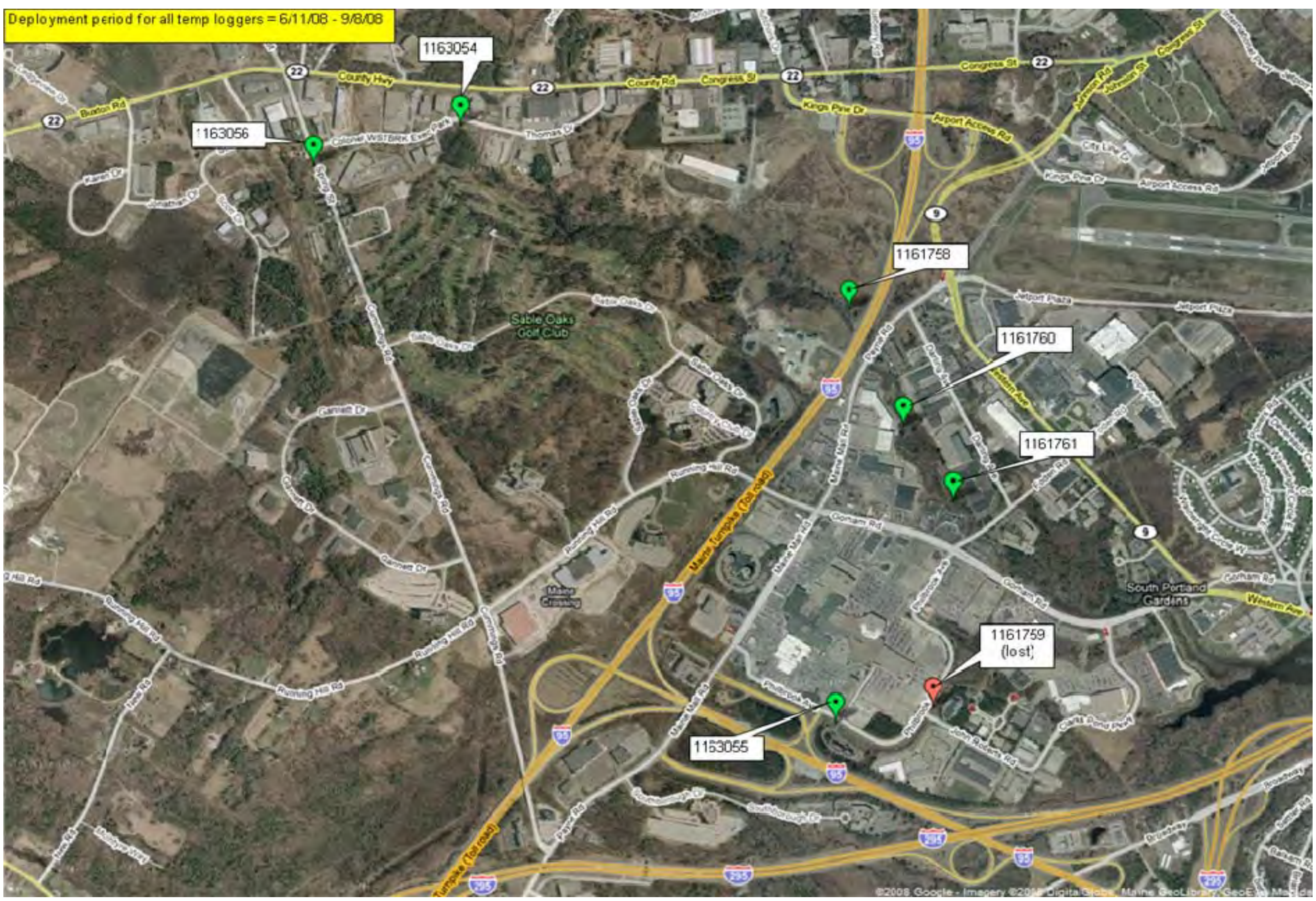


Figure 3h: *Locations of temperature data logger deployments in the Long Creek watershed*

3.5 Water Temperature Assessment

Inadequate riparian vegetation or shading and extensive areas of IC adjacent to nearby streams may adversely affect aquatic biota by increasing the temperatures of stormwater runoff during the summer months. To study the extent to which these conditions were impacting Long Creek and its tributaries, seven temperature data loggers were deployed at various locations throughout the Long Creek watershed from June 11th – September 8th, 2008 (Figure 3h, p. 24). Temperature responses in other urbanized Maine watersheds have shown marked increases immediately following sudden storm events in the summer and a preliminary analysis of results for some of the Long Creek sites indicates similar responses. Additionally, temperatures exceeding approximately 24° C (75.2° F) have been shown to be detrimental for brook trout habitat (EBTJV, 2005). All of the study sites experienced periods where temperatures exceeded this threshold. Temperature plots for each site for the entire deployment period are presented in Appendix 4.

Photo: South Portland Land Trust

4. Management Plan Rationale and Approach

4.1 Goals and Objectives for Restoration

The ultimate aim of the Long Creek Restoration Project is to improve watershed conditions sufficiently to attain water quality classification standards. The underlying premise supporting this ambitious effort is that urban areas do not have to cause damage to watershed health, and that citizens, businesses, government, and other stakeholder groups can be responsible stewards of the Long Creek watershed. The goals and objectives needed to achieve watershed restoration for Long Creek will require a comprehensive and integrated set of activities as indicated in Table 4a.

Table 4a: *Long Creek Watershed Restoration Objectives (adapted from 2005 Portland, OR Watershed Management Plan)*

Goals	Watershed Restoration Objectives
Water Quality Improvements	Urban Pollutants: manage sources and transport of urban stormwater pollutants and nutrients to restore and protect watershed health and achieve applicable water quality standards (which includes supporting diverse healthy aquatic communities).
	Temperature and Dissolved Oxygen: improve stream temperatures and dissolved oxygen to restore and protect watershed health and achieve applicable water quality standards (which includes supporting diverse healthy aquatic communities).
Physical Habitat Improvements	Aquatic Habitat: improve aquatic, riparian, and floodplain habitat extent and quality to support the return and persistence of diverse native fish (especially brook trout) and macroinvertebrate communities.
	Terrestrial Habitat: improve riparian habitat extent, and quality to support the persistence of native terrestrial communities and connectivity to aquatic and riparian habitats.
Hydrology Improvements	Stream Flow: protect and increase runoff infiltration and detention areas to normalize stream hydrographs and reduce stormwater flow to storm sewer systems.
	Channel and Floodplain Functions: protect and restore the extent, connectivity, and functions of streams, open drainageways, wetlands, riparian areas and floodplains to improve bank stability and natural hydrologic functions and reduce risk to built environment and human safety.

4.2 Structural Restoration Rationale for the Built Environment

The Long Creek watershed contains over 600 acres of impervious surfaces. Many of these impervious surfaces receive little or no stormwater water quality treatment prior to discharging pollutants to Long Creek and its tributaries. Consequently, structural stormwater management retrofits will be a necessary component of the Long Creek restoration effort. As discussed in Section 3, there is a well-documented correlation between overall watershed imperviousness and the levels of impairment within the affected streams. Watershed IC by itself is an appropriate preliminary indicator of aquatic impairment, but there are other related factors that influence the impact of impervious surfaces on stream conditions. These include:

- The "directly-connected" nature of the impervious surface (directly connected impervious surfaces have little or no potential for the attenuation of stormwater pollutants before entering surface waters);

- The use and management of the impervious surface; and
- The extent and type of structural and non-structural stormwater management practices for the impervious surface.

These basic criteria helped guide the development of a stormwater retrofit inventory that resulted in the identification of specific structural retrofit opportunity locations that were used to develop priority project areas within the Long Creek watershed.

The technical team organized a Technical Advisory Committee (TAC) that met four times during the course of the watershed planning project. The primary function of the TAC was to guide the retrofit assessment process and subsequent development of the action items within the plan. The initial TAC meetings solicited stakeholder input to identify pending capital improvements or planned projects that might incorporate stormwater management. A resulting list of public and private project opportunities was developed to assist the project team in refining the specific focus areas for the structural stormwater retrofit inventory and to develop recommendations for non-structural restoration practices.

Due to the extent of impervious surfaces within the watershed, the technical team proposed field evaluation of "focus areas." The focus areas were determined based on directly connected impervious areas and parcel or catchments with minimal existing engineered stormwater quality treatment systems. The directly connected impervious areas were identified through a detailed review of aerial photos, base map data and storm sewer infrastructure, which consisted of a 2006 inventory of existing stormwater systems in the Maine Mall area. The results were developed into a general focus area map that was presented to the TAC for review. To provide the "biggest bang for the buck," impervious areas that did not meet these two basic criteria (directly connected and minimal or no treatment) were excluded from the field stormwater retrofit inventory because they were assumed to pose a smaller risk to water quality impairment in the Long Creek watershed.

The overall goals of the stormwater retrofit inventory were to identify structural stormwater retrofit opportunities that could be implemented:

- With limited impact on existing infrastructure;
- To attenuate some of the primary contributors of untreated stormwater pollution in the watershed; and
- In a cost-effective manner (BMP implementation cost in relation to impervious area treated.

The general focus areas were field assessed for portions of developed parcels that had the potential to provide surface space for structural stormwater BMPs. In some cases, below grade retrofits were suggested for locations with apparently sufficient elevation to provide positive drainage. The field inventory included the assessment of surface elevations, retrofit site proximity to existing drainage infrastructure, and an evaluation of potential surface constraints. Additional details of the field inventory are provided in Appendix 6. It was beyond the scope of the assessment to consider the full range of below grade utility conflicts. Ultimately, the results of the field stormwater retrofit inventory were used as the basis of a prioritization of specific catchment areas of the Long Creek watershed that provide the best opportunity to mitigate existing stormwater discharges. The results and recommendations associated with this inventory are outlined in Section 5.

4.3 Non-structural Restoration Rationale for the Built Environment

Non-structural watershed restoration practices prevent or reduce stormwater related runoff problems by reducing the exposure and generation of pollutants and providing a regulatory framework that minimizes impervious surfaces. Non-structural approaches to watershed restoration can be the most cost-effective and holistic practices within a watershed management framework. Many of the non-structural approaches recommended in this plan can not only improve water quality but can also enhance watershed aesthetics (e.g., through shade tree planting, expanded landscaping and trash reduction), streamline the permitting process (e.g., by removing conflicting design or stormwater codes) and reduce development costs (e.g., by minimizing the need for as much paved parking area).

There are three primary components of non-structural BMPs:

- Land use planning and standards promoting design and construction that minimizes or eliminates adverse stormwater impacts;
- Pollution prevention and good housekeeping measures aimed at minimizing exposure and release of pollutants; and
- Education and outreach to encourage broader implementation of BMPs and to promote awareness of the connection between land use, water quality and the health of riparian and in-stream habitats.

4.3.1 Planning Considerations

In watersheds with future development potential, municipalities need to develop land use and zoning criteria to prevent any increase in pollutant loadings from new development that may offset reduced loads that result from implementing watershed management plans (CWP – Manual 3, 2007). Zoning in the Long Creek watershed presents considerable opportunity for continued development and redevelopment—particularly in the Rural Residential / Farming zone of Scarborough and Industrial Business Park District of Westbrook

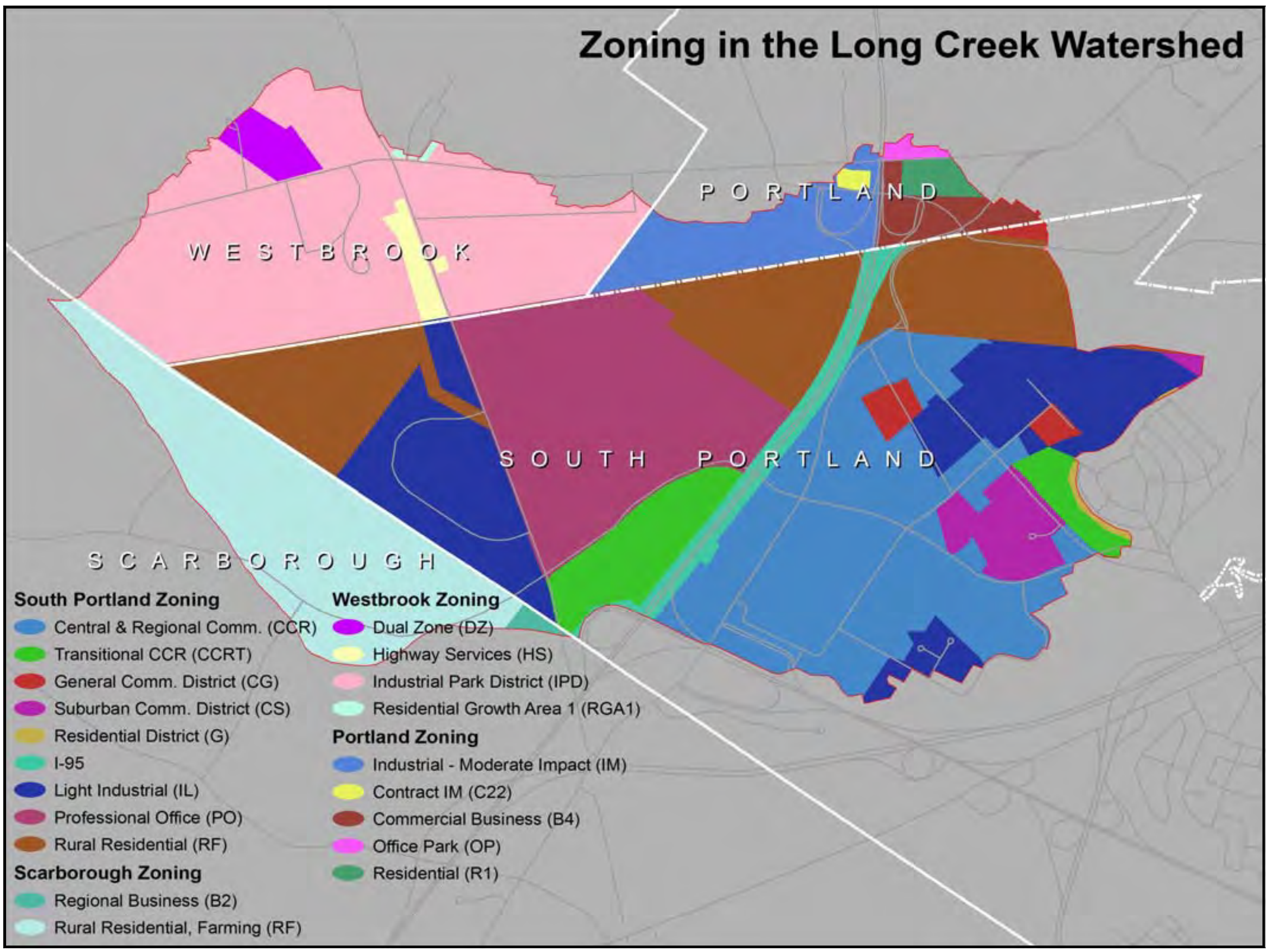


***Figure 4a:** Zoning in the Long Creek watershed .*

(Figure 4a, p.28).

In the absence of enhanced land use and zoning requirements, continued development in this area has the potential to further degrade watershed condition. Table 4b provides a brief overview of the primary watershed zones and zone specific requirements that can influence parcel IC and pervious area. (Portland was not included in this analysis as little development/redevelopment potential exists in its portion of the watershed).

Table 4b: *Zoning standards for communities with developable land in Long Creek watershed.*

	Watershed Zone Name	Maximum Builing Coverage	Minimum lot size of all uses (sq ft)	Minimum frontage of all uses (feet)	Minimum front yard setback (feet)	Minimum rear yard setback (feet)
South Portland	Professional Office District PO	30 percent	2 acres	150 feet	50 feet	25 feet
	Light Industrial District IL	None Listed	30,000 sq ft	100 feet	20 feet	20 feet or 50% of building height
	Central and regional commercial district CCR	30 percent	20,000 sq ft	75 feet	50 feet	20 feet or 50% of building height
	Transitional central and regional comercial district CCRT	30 percent	20,000 sq ft	75 feet	50 feet	20 feet or 50% of building height
Scarborough	B2- General Business	50 percent	10,000 sq ft		50 feet*	15 feet*
	RF- Rural, residence, farming	25 percent	80,000 sq ft	200 feet	50 feet	15 feet or 50% of building height
Westbrook	Highway Services	None Listed	15,000 sq ft	100 feet	30 feet	30 feet
	Industrial Park District	None Listed	20,000 sq ft	200 feet	40 feet	30 feet

	Watershed Zone Name	Minimum side yard setback (feet)	Notwithstanding side or rear yard setback from each side of a stream (feet)	Minimum Landscape open space	Maximum Footprint Factor	Maximum Gross Density Factor
South Portland	Professional Office District PO	30 feet	100 feet	30 percent gross lot area	-	-
	Light Industrial District IL	20 feet or 50% of building height	100 feet	25 percent gross lot area	-	-
	Central and regional commercial district CCR	20 feet or 50% of building height	100 feet	20 percent of gross lot area	-	-
	Transitional central and regional commercial district CCRT	20 feet or 50% of building height	100 feet	30 percent of gross lot area	-	-
Scarborough	B2- General Business	15 Feet*	-	-	-	-
	RF- Rural, residence, farming	15 feet or 50% of building height	-	-	-	-
Westbrook	Highway Services	30 feet	-	25 percent	40 percent	75 percent
	Industrial Park District	30 feet	-	20 percent	50 percent	80 percent

In watersheds with significant development or redevelopment potential, the Center for Watershed Protection identifies "requiring stormwater treatment for redevelopment projects" as the single greatest mechanism for enhanced stormwater management over the long-term (Figure 4b, p. 30). Additionally, a recent water policy publication by American Rivers identified local land use planning and zoning ordinances as the most valuable components of watershed protection even exceeding federal Clean Water Act requirements (Denzin, 2008). The ten guidelines outlined as key steps in local water policy innovation are as follows:

1. Review current zoning ordinance for regulatory barriers and quick improvements
2. Set performance based standards
3. Take additional measures to reduce impervious surfaces
4. Promote the use of a few specific Low Impact Development (LID) designs
5. Use overlay districts to add new requirements to existing zoning districts
6. Establish standards or incentives to improve stormwater management in developed areas
7. Address storage/use of pollutants that contact stormwater
8. Create and protect buffers to vital water resources
9. Require use of Low Impact Development (LID) designs for municipal projects
10. Connect zoning decisions to a comprehensive plan

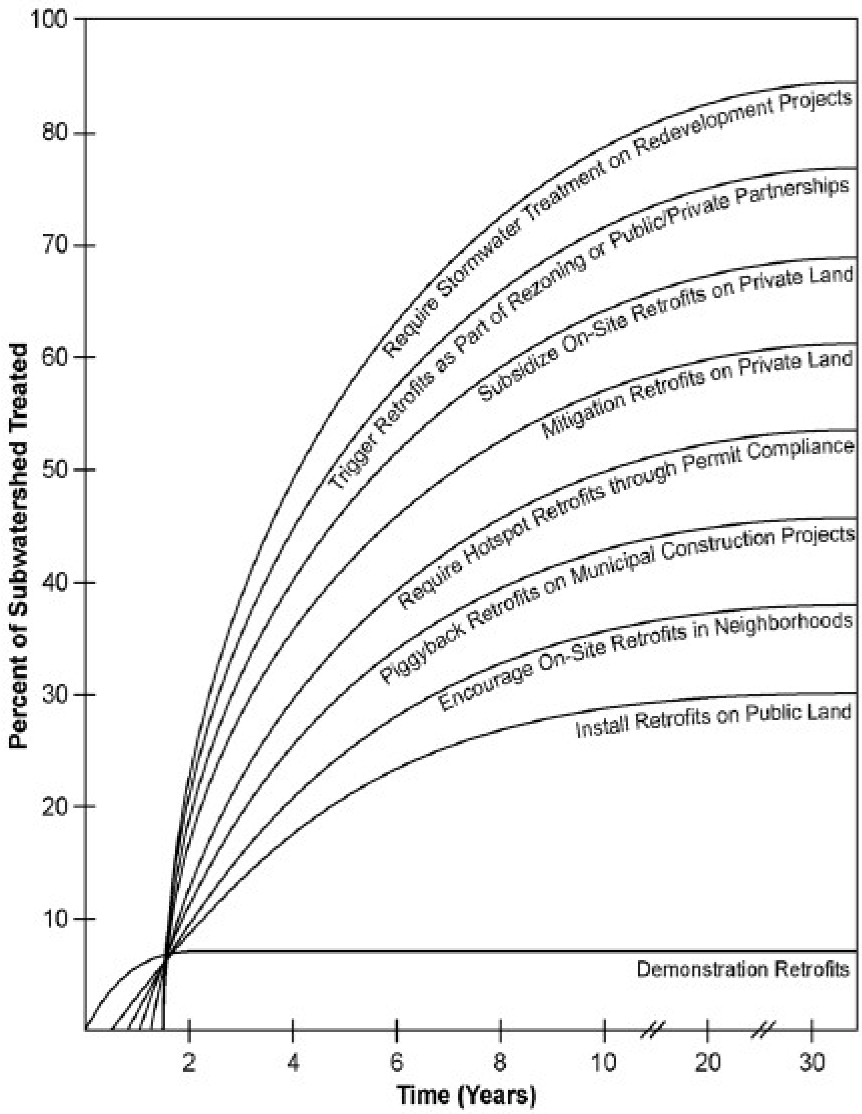


Figure 4b: *Effectiveness of various restoration strategies in treating stormwater. Requiring stormwater treatment for redevelopment projects provides the greatest stormwater treatment benefit. (Source: Center for Watershed Protection)*

To examine how local land use regulations influence stormwater policy, the project team conducted a preliminary review of zoning ordinances for the three communities with additional development potential. The evaluation focused on the regulatory provisions influencing the amount of impervious surfaces associated with development / redevelopment projects. There are three local zoning requirements that generally dictate the amount of impervious surface created for each new or redevelopment project:

- Off-street parking;
- Local street width; and
- Parking stall dimensions.

Communities often maintain minimum off-street parking requirements as a means of providing a sufficient number of parking spaces for a given commercial or residential use. Local street width regulations specify minimum pavement widths for appropriate access, safety and maintenance. Parking stall dimensions allow for appropriate turning radius access and protect parking users from adjacent parked vehicles.

Each of these requirements has a direct influence on the resulting impervious cover of a given parcel. There are also significant private sector factors that contribute to a parcel's impervious cover such as developer finances, development type and perceived real estate attractiveness. These factors cannot be expected to be changed through local code adjustments. Table 4c compares the current off-street parking requirements in each community in the Long Creek watershed against the Low Impact Development recommended standards.

***Table 4c**: Comparison of current local off-street parking standards with recommended LID requirements*

City	Commercial Use	Required Number of Parking Spaces	LID standard parking requirements
South Portland	General Retail	5 spaces per 1000 sq ft Gross Floor Area (GFA)	4.5 per 1000 sq ft GFA
South Portland	Shopping Center	5 spaces per 1000 sq ft GFA	4.5 per 1000 sq ft GFA
South Portland	Office, Professional, public building	2.9 per 1000 sq ft FA*	3 per 1000 sq ft GFA
Westbrook	General Retail	6 per 1000 sq ft of sales area	4.5 per 1000 sq ft GFA
Westbrook	Major Retail Center	5.5 per 1000 sq ft	4.5 per 1000 sq ft GFA
Westbrook	Office, Bank, Funeral Home	5 per 1000 sq ft	3 per 1000 sq ft GFA
Scarborough	Retail sales and service, Retail business	5.5 per 1000 sq ft gross lease space	4.5 per 1000 sq ft GFA
Scarborough	Business Service and business office	5.5 per 1000 sq ft gross lease area	3 per 1000 sq ft GFA
* Floor area over 2000 sq ft, 1 space for each 350 sq ft of floor area exclusive of areas used for storage			

While there are differences between gross floor area and sales area or lease area, in most cases the off-street parking requirements for all three communities are in excess of the Low Impact Development recommended minimum. The LID standards expressed in Table 4c are based on the Massachusetts LID Toolkit and the Center for Watershed Protection Code and Ordinance Worksheet. Additionally, the off-street parking requirements were compared to national averages and ranges as reported by the Institute of Transportation Engineers (ITE), Parking Generation Study – 3rd Edition (Table 4d, p. 32). LID guidance also recommends additional off-street parking reductions where multi-modal transportation is available and for compact car parking only, and shared parking options.

It is likely that parking demand in many commercial areas of the watershed will exceed LID recommended off-street parking requirements during peak periods; however, it is also likely that parking needs will be easily met by LID recommended off-street parking requirements during the vast majority of the year based on ITE studies. Each municipality must determine what level of need should be met for each land use type and closely examine whether viable parking reduction strategies exist. Examples include incentive programs for increased transit use and ride sharing, improving and expanding bicycle and pedestrian infrastructure, and other transportation demand management strategies.

Table 4d: *Peak parking demand for typical commercial land uses*

	Parking Generation Study: Shopping Mall-Saturday during December	Parking Generation Study: Shopping Mall-Saturday during non-December	Parking Generation Study: Suburban office building weekday	Parking Generation Study: Urban office building weekday
Average peak period parking demand	4.74 vehicles per 1,000 sq ft GFA	2.97 vehicles per 1,000 sq ft GLA	2.84 vehicles per 1,000 sq ft GFA	2.4 vehicles per 1,000 sq ft GFA
95% Confidence Interval	4.48-5.0 vehicles per 1,000 sq ft GFA	2.66-3.28 vehicles per 1,000 sq ft GLA	2.73-2.95 vehicles per 1,000 sq ft GFA	
Range	2.01-7.5 vehicles per 1,000 sq ft GFA	1.85-4.82 vehicles per 1,000 sq ft GLA	.86-5.58 vehicles per 1,000 sq ft GFA	1.46-3.43 vehicles per 1,000 sq ft GFA

Required minimum parking stall width can also influence the amount of pavement on a given parcel (Table 4e). It is generally accepted that different commercial or office uses (e.g. fast food restaurants versus professional office buildings) may require different dimensions to protect personal property, but the establishment of minimum standards consistent with LID recommendations will increase flexibility for site designers and decrease costs for developers in appropriate locations. The requirement for a 10' x 20' parking stall over the 9' x 18' LID-recommended dimensions increases impervious surface and construction materials within parking stall portions of a parking lot by nearly 20%.

Table 4e: *Local and LID parking stall width requirements*

City	Parking Stall Angle	Required Stall Width	LID Standard Stall Width	Required Stall Depth	LID Standard Stall Depth
South Portland	90	9'	9' or less	18'	18' or less
Westbrook	90	9'	9' or less	18'5"	18' or less
Scarborough	90	10'	9' or less	20'	18' or less

Other areas within municipal design standards that can influence stormwater management on a developed parcel are street widths, curbing requirements and rooftop runoff reuse restrictions. Road design guidelines often require minimum street widths and continuous curbing within a new subdivision or local road extension. While curbing protects pedestrians within the urban environment, it necessitates the development of below grade piped stormwater drainage. The concentration of stormwater within pipes is generally inconsistent with LID recommendations such as disconnection of impervious surfaces. In order to avoid unnecessary regulatory hurdles to implementation of LID practices, municipalities should consider allowing curb cuts for stormwater diversion or no curbing when appropriate. Table 4f summarizes these parameters for each of the watershed municipalities.

Table 4f: *Local and LID parking stall width requirements*

City	Allows shared parking	Allows parking reductions for multi-modes of transportation	Allows compact car parking spaces for overall parking reduction	Percent compact car parking spaces allowed	LID compact car recommendati ons	Street width requirements	LID local street width recommendati ons
South Portland	Yes	No	Yes	No more than 30%	No more than 30%	Local streets 30' Industrial and	18-22 feet
Westbrook	No	No	No	No	No more than 30%	Local streets 24' Private way	18-22 feet
Scarborough	No	No	No	No	No more than	-	18-22 feet

Rooftop downspouts are often tied into the overall stormwater management system of a developed parcel. In many cases this common design adds relatively clean stormwater to polluted parking lot runoff decreasing the capacity downstream treatment systems and compromising their overall effectiveness. While rooftops can contribute bacteria, warm stormwater and metals into a stormwater waste stream, they should be considered under separate treatment strategies by designers. Rooftop runoff separation, storage and/or reuse are consistent with LID strategies but are not often promoted, recommended or referenced in local or state design standards. The MEDEP strongly endorses the use of LID practices and should consider allowing a reduced level of water quality treatment for disconnected rooftop runoff. This policy would likely promote management of these impervious surfaces separately on new and redevelopment projects improving overall parcel stormwater management. Table 4g summarizes how each watershed municipality addresses curb cuts for stormwater diversion and the disconnection of rooftop runoff from the stormwater system.

Table 4g: *Local regulations pertaining to curb cuts and rooftop runoff disconnection*

City	Allows curb cuts	Promotes disconnection of rooftop runoff
South Portland	No	No reference
Westbrook	No	No reference
Scarborough	No	No reference

In summary, a review of local zoning requirements and code and design guidelines for municipalities with developable land within the Long Creek watershed indicates that changes in ordinances will assist in overall watershed restoration, reduce developer burden under impervious management standards and reduce variance requests from local stormwater management standards. As future development and redevelopment will continue to influence the overall land cover within the Long Creek watershed, a comprehensive review and update of stormwater code and associated zoning requirements will provide water quality improvements within Long Creek over the long-term. Section 5 provides an overview of specific recommendations for enhanced local and state stormwater policy.

4.3.2 Pollution Prevention Rationale

The EPA defines pollution prevention as reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing conservation techniques, and re-using materials rather than putting them into the waste stream. They also indicate that there is an increasing recognition of the role of pollution prevention rather than structural treatment only in long-term watershed management programs (Muthukrishnan, 2004). Impervious surfaces concentrate pollutants that can be washed off during rainfall or snowmelt. Streets and parking areas currently make up a significant portion of the land area in the Long Creek watershed. Extensive parking areas are primarily located in the commercially-developed eastern portions of the watershed and occupy approximately 358 acres (16% of the watershed). Additionally, the watershed is bisected by the Maine Turnpike, has two exits off Interstate 95 and serves as an important thoroughfare for other state and local roadways. Runoff from most roadways and many parking areas is directly connected to the storm drain system and Long Creek without engineered treatment and often with minimal natural buffer between outfalls and the stream. Streets and parking areas can be significant sources of polluted runoff, including suspended solids, nutrients, metals and bacteria. Additionally, parking and roadways can be a significant source of thermal pollution due to elevated temperatures of asphalt pavement in the summer months.

There are four primary good housekeeping efforts that can help to minimize polluted stormwater runoff from impervious surfaces.

- Pavement Sweeping
- Alternative Winter Maintenance
- Pollution Prevention Measures

- Landscaping Management BMPs

The following should be considered as general guidance for public and private good housekeeping. Specific programmatic recommendations are presented in Section 5.

Pavement Sweeping

Pavement sweeping is a common maintenance activity and is typically undertaken for safety and aesthetic purposes in the spring after snowmelt for "winter sand" removal, in the summer for trash and in the fall for leaf removal. A sweeping strategy when properly designed and implemented can also have significant benefits for water quality. A USGS study in the Charles River watershed in Massachusetts indicated that an aggressive sweeping effort could reduce phosphorus runoff by 20% and metals and sediment by 30-45% (USGS, 2003). This decrease in pollutant loads was a result of sweeping with the best available technology on a weekly or biweekly schedule. Extensive street sweeping research in the Midwest indicates that vacuum and regenerative air sweepers may reduce subwatershed total suspended solids (TSS) pollutant loads by 20-40% (Bannerman and Pitt, 2004). These reductions in pollutant loads are similar to many structural stormwater treatment devices.

Sweeping all paved surfaces within the watershed on a weekly basis may not be realistic but a targeted sweeping program will improve stormwater quality. A targeted sweeping program will require coordination among watershed landowners, municipal managers and state transportation agencies for development and implementation. Considerations in establishing a pavement sweeping program to reduce stormwater pollutant loads include:

- ***Equipment:*** there is great variety among street sweepers with three primary categories - mechanical broom, vacuum and regenerative air.
  - ◊ Mechanical broom sweepers are by far the most common in Maine and are effective at picking up large particulate matter and cleaning on wet surfaces. They are typically less costly to operate than other types, but generate dust and are not very effective at removing fine particulate removal, where most pollutants are attached.
  - ◊ Vacuum and regenerative air sweepers are much more effective at removing fine particulate material, which is important because fine particles are the sources of many pollutants. These sweepers are less effective for heavy material loads but improving technology is increasing sweeper efficiency and many companies specifically market stormwater improvement as a function of their sweepers.

Figure 4c: *example of regenerative air vacuum sweeper*

- ***Timing:*** spring sweeping as soon as possible after snow melt, early summer after seed and flower drop, mid-summer after prolonged dry periods and fall after leaf drop are considered optimal sweeping times for nutrient reduction. For best results sweeping should be conducted prior to runoff producing rain or melt events, particularly after extended dry periods in the summer.
- ***Hot spots:*** busy traffic areas of retail commercial facilities such as drive-thrus and short-term parking facilities along with other hot-spots could require more frequent or targeted sweeping. Specific parking areas that generate significant debris, commercial loading and unloading zones or construction entrances should be swept as part of targeted sweeping plan. Property owners of hot-spots could be asked to implement hydrocarbon or other pollutant reduction controls through the use of low-cost hydrocarbon absorbing catch basin inserts or catch basin outlet hoods.
- ***Techniques:*** sweeping should be done by highly trained operators and in a way that reduces the amount of materials being pushed toward storm drain inlets. Sand should also be raked from adjacent turf areas prior to sweeping. Disposal of street sweeping residuals should follow MEDEP guidelines for residual material disposal.

Alternative Winter Maintenance

Sand and salt are considered pollutants. As discussed in Section 3, there have been excessive amounts of chloride found in Long Creek. In all likelihood, this contamination has originated from salts used for deicing paved areas in the winter (Figure 4d). These materials are easily carried into storm drains and water ways contributing to impairment problems in Long Creek. Salts are soluble and highly mobile and often run off before sweeping can begin. Currently there are alternative deicing products on the market that can be applied in place of salt, particularly for use on targeted areas of commercial facilities. The precision and timing of salt application is also an important consideration since there are existing methodologies to meter the proper amount of salt at the proper time.

Figure 4d: *Salt application for deicing paved areas in the winter is likely contributing to Long Creek's chloride impairments.*

Salt alternatives are being utilized primarily to reduce corrosive impact on concrete but are more expensive than conventional deicers. One commercially available example is calcium magnesium acetate (CMA), which can cost three times more than calcium chloride and is only effective down to 15° F (similar to rock salt). Calcium chloride is effective to -25° F. Other commercially available winter deicer alternatives are Sodium Acetate and Calcium Magnesium Propionate. There are concerns that deicer alternatives could generate excessive Biological Oxygen Demand (BOD) in runoff water but some literature suggests that this is not evident in field research (Tanner and Wood, 1999). Careful evaluation of these alternatives is suggested prior to extensive use within the Long Creek watershed.

Pollution Prevention Measures

Pollution prevention generally consists of a materials management and an alternative product substitution component (EPA/600/R-04/184). Materials management includes the appropriate management and safe handling of common chemicals or substances that may be exposed to stormwater runoff. These materials include fertilizers, pesticides and herbicides, cleaners, automotive products and commercial trash and waste. Pollution prevention BMPs should consider material use controls, material storage controls, and material disposal controls.

Alternative product substitution involves the use of more environmentally benign versions of commonly used toxic substances. A notable example with particular relevance for the Long Creek watershed is the use of pavement resurfacing sealants. Coal-based tar pavement sealants (CTS) have become a focus of pollution prevention efforts in numerous communities across the country. Lowe's and Home Depot have discontinued the sale of CTS nationwide as a result of bans in some communities. Available alternative asphalt-based sealants can contain up to 600 times less Polycylic Aromatic Hydrocarbons (PAHs) than CTS. As such, a coordinated program to evaluate and provide information concerning the use of parking lot sealants in the Watershed is recommended in Section 5. At this time it is not clear to what extent either of these products are being used within the Long Creek watershed.

Landscape Management

Landscaping and landscape related fertilizers, pesticides and herbicides can have a negative impact on watershed health. Lawn areas can account for up to two-thirds of the phosphorus load in an urban watershed (Waschbusch, Selbig and Bannerman, 1999) and research related to phosphorus-free fertilizer ordinances has shown a reduction up to 50% of total phosphorus in runoff from lawns in areas with phosphorus-free fertilizer ordinances (Garn, 2006). Additionally, the Maine Board of Pesticide Control has documented a sharp rise in the use of pesticides in the state from 800,000 pounds in 1995 to 3,000,000 pounds in 2004. Most of this increase is related to "weed and feed" products for commercial and residential use. In addition to providing water quality benefits, a reduction in fertilizer use, pesticides and herbicides can help save commercial landowners on annual landscaping costs.

Pavement shading is also an important consideration in restoring and protecting aquatic health. Pavement temperatures can easily exceed 120° F during the summer months. Large variations in temperature in streams due to heated summer runoff can stress aquatic organisms. As noted in Section 3, Long Creek experiences significant spikes in temperature immediately following a summer thunder shower. Tree shade has been shown to reduce pavement temperatures and increase the longevity of pavements (McPherson and Muchnick, 2005). Therefore, Section 5 offers specific landscape management recommendations to increase pavement shading throughout the watershed.

Figure 4e: Example of an education and outreach logo to raise awareness about stormwater pollution

4.3.3 Education and Outreach Rationale

Actively engaging watershed stakeholders in efforts to minimize the impacts from stormwater runoff in Long Creek and its tributaries will be critical to the overall success of the Restoration Project. Education and outreach is therefore an essential means to promote and support responsible stewardship among citizens, businesses, government, and other watershed stakeholders. The State of Maine has created a variety of educational resources for addressing stormwater pollution (Figure 4e). Promoting community education, public involvement and watershed stewardship will directly benefit the Long Creek Restoration Project by:

- Helping property owners and managers understand how their activities affect watershed conditions;
- Showing property owners and managers how their individual behaviors and actions can collectively promote healthy watersheds;
- Increasing stewardship of municipally-owned natural areas; and
- Increasing community interest in watershed stewardship grants and restoration projects that improve watershed health.

Education, involvement and stewardship raise awareness of watershed issues and the importance of healthy watersheds. Outreach efforts encourage property owners to get involved and protect natural resources, prevent pollution and creatively integrate stormwater into the built environment. This strategy will increase awareness of watershed health issues and the acceptance of the innovative and effective stormwater management practices identified here in the Long Creek Watershed Management Plan. Specific education and outreach recommendations are discussed in Section 5.

4.4 Rationale for Addressing the Aquatic Environment

Degradation of aquatic environments is a trend that is common in urbanizing watersheds. In the United States, urbanization is the second leading cause of stream impairment after agriculture, even though the total area of urban land use is much smaller than agricultural land uses (Paul and Meyer 2001). As discussed previously, common types of stream impairment caused by urbanization include changes in stream hydrology, geomorphology and stability, water quality, habitat and biodiversity. More specifically, these changes result in losses of riparian shading, attachment sites for macroinvertebrates, feeding and spawning areas for fish, and suitable habitat for all aquatic organisms. As a consequence, aquatic ecosystems experience decreases in species richness, decreased abundances of sensitive organisms, and increased abundances of pollution tolerant organisms (Paul and Meyer 2001). Identifying the numerous and diverse impacts to the Long Creek watershed's aquatic ecosystem that would be targeted as potential high value and high priority restoration projects was accomplished by conducting three primary types of assessments: riparian, in-stream and geomorphic. The rationales for each of these assessment types are discussed below.

4.4.1 Riparian Assessment Rationale

The rationale for assessing the riparian areas of the Long Creek watershed primarily derived from the connection between the effects of shoreland and floodplain vegetation on stream temperatures and pollutant runoff attenuation. As discussed in Section 3, the riparian assessment identified extensive areas that were either completely lacking or largely absent of vegetation in the shoreland or upland zones. Restoration recommendations to improve vegetation conditions in the riparian zones address multiple enhancements to Long Creek's ecosystem, including:

- ***Shading*** that reduces water and ambient air temperatures. Cooler water allows for greater concentration of dissolved oxygen and provides the conditions needed for proper growth and reproduction of key aquatic species (particularly those required to attain aquatic life standards). Streams exceeding temperature thresholds (like Long Creek) may not be able to support certain species of aquatic organisms that would be expected to reside there. Additionally, healthy vegetated riparian areas adjacent to streams are also considered important in supporting adult life stages of aquatic insects and their dispersal along the lengths of stream corridors (Petersen et al., 2004).
- ***Bank stability***, which is largely determined by the extent of vegetation and is important because it directly affects stream ecology in terms of sediment input in a stream system. Increased sediment loads produced by the change in the landscape from development can adversely impact the health of aquatic organisms. The root systems of riparian vegetation help maintain bank stability and help minimize soil loss while a lack of riparian vegetation increases the likelihood of stream bank collapse.
- ***Sustainable food sources and habitats for aquatic communities***, which originate from long-term input of leaves and wood. Trees and shrubs on the edge of streams provide large pieces of wood that serve as stable areas for macroinvertebrates and cover for fish while leaves from this vegetative cover provide a food source for macroinvertebrates.

4.4.2 In-Stream Habitat Assessment Rationale

Field visits by MEDEP staff to Long Creek and its tributaries have clearly identified many segments in the watershed that lack the in-stream habitat needed to provide adequate living conditions for key aquatic species (macroinvertebrates and coldwater fish). In particular, the absence of large pieces of wood (e.g., downed trees, branches, root masses) is a prominent characteristic of a degraded aquatic habitat. Large wood pieces play a very important role in stream ecology (especially low-gradient, sandy-bottomed streams like Long Creek) by acting as a stable substrate for macroinvertebrates; providing cover for fish; trapping leaves (food resources for macroinvertebrates); maintaining a natural stream morphology; and enhancing in-stream habitat and flow diversity. For these reasons, addition of large pieces of wood to Long Creek and its tributaries is the central component of the in-stream habitat restoration strategy. Appendix 5 provides a literature review of relevant research on the importance of large wood to stream habitats and biological communities. Secondarily, as an alternative method to enhance in-stream channel structure and habitat diversity, the addition of large boulders will be considered in stream sections where the risk of restoration materials (i.e., wood) is threatened to be washed out of the system due to high stormwater flows.

4.4.3 Geomorphic Assessment Rationale

Geomorphology provides a powerful tool in establishing the relationship between external land-based influences on stream channel stability. This is particularly important for assessing the effects of the built environment on overall stream health since the science of geomorphology can predict the stream modifications that will occur in response to land use changes in the contributing watershed. Recent geomorphology assessments in the Long Creek watershed concluded that various human activities in and near Long Creek and its tributaries have altered pre-development conditions in four distinct ways (Field, 2005, 2006):

1. Straightening of stream channels (typically done for flood control) that has resulted in channel widening and excessive sediment accumulation;
2. Channel down-cutting (deepening) that has resulted from floodplain constriction by stormwater retention basins;
3. Sudden increases in peak stream flows and volumes leading to stream bank erosion and the creation

of multiple channels below stream segments and culverts confined by development; and

4. Channel straightening and confinement of channels against high banks of natural marine deposits or artificial fill.

Recommended restoration strategies presented in Section 5 address each of these four major problems types so that Long Creek and its tributaries can move towards a pre-development habitat condition in support of the reestablishment of healthy aquatic communities.

Photo: Jeff Varricchione, MEDEP

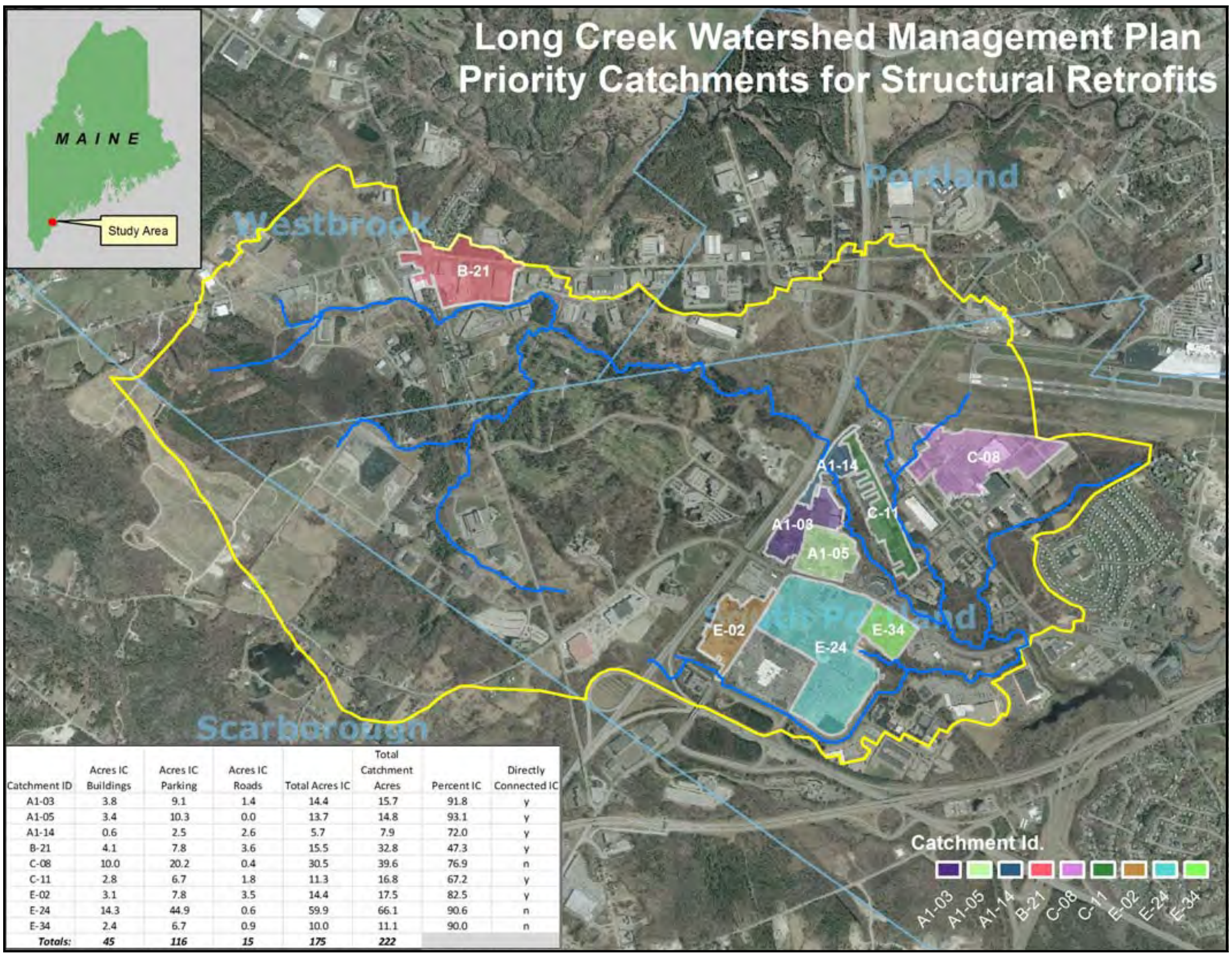
5. Plan Implementation

5.1 Watershed Action Strategy

The key components of the Watershed Action Strategy to restore Long Creek and its tributaries are described in detail below with supporting documentation in the Appendices. These consist of restoration recommendations for the built environment that include both structural and non-structural BMPs. For the aquatic environment, they include a variety of strategies to restore in-stream and riparian habitats as well as areas with degraded floodplains. As discussed in Section 4, each set of recommendations has been prioritized separately through technical analysis and an extensive stakeholder review process.

5.2 Structural Management Opportunities for the Built Environment

As some level of enhanced structural stormwater management will be required for the restoration of Long Creek, the project team has identified retrofit opportunities within priority MEDEP catchment areas that exhibit the most potential for water quality enhancement with minimum capital investment and maximum partnership potential (Figure 5a). These opportunities have been identified through field evaluation but will require detailed survey and engineering design in order to determine the appropriate final implementation strategy for maximum water quality benefits.



Catchment ID	Acres IC Buildings	Acres IC Parking	Acres IC Roads	Total Acres IC	Total Catchment Acres	Percent IC	Directly Connected IC
A1-03	3.8	9.1	1.4	14.4	15.7	91.8	y
A1-05	3.4	10.3	0.0	13.7	14.8	93.1	y
A1-14	0.6	2.5	2.6	5.7	7.9	72.0	y
B-21	4.1	7.8	3.6	15.5	32.8	47.3	y
C-08	10.0	20.2	0.4	30.5	39.6	76.9	n
C-11	2.8	6.7	1.8	11.3	16.8	67.2	y
E-02	3.1	7.8	3.5	14.4	17.5	82.5	y
E-24	14.3	44.9	0.6	59.9	66.1	90.6	n
E-34	2.4	6.7	0.9	10.0	11.1	90.0	n
Totals:	***45***	***116***	***15***	***175***	***222***		

Figure 5a: *priority MEDEP catchments for structural retrofits.*

Table 5a: Suggested Structural Retrofit BMPs
Gravel Wetland
Roof Drip Edge Filter
Below Grade Treatment Train
Below Grade Storage with Filter
Esplanade Filter Box
Pervious Pavement Alteration
Dry Detention
Diversion to Buffer
Outlet Stabilization and Outlet Sediment Control

The field stormwater retrofit inventory resulted in the identification of 165 individual stormwater retrofit management opportunities. This inventory also attempted to identify surface stormwater retrofits that have "value-added" community benefits, such as landscape enhancement. The retrofit inventory generally followed the principles of Low Impact Development where the use of multiple, small structures is preferred over the use of single, large structures. The inventory focused on nine recommended BMPs for structural retrofits (Table 5a). Description of BMPs, field inventory methods, field form data inputs and complete stormwater retrofit database results are available in Appendix 6.

In order to identify targeted, practicable structural stormwater management opportunities, individual retrofits were prioritized by catchment area and are referred to as "Priority Catchments". The MEDEP delineated catchments represent the developed land area that contributes runoff to a distinct stormwater outfall. The catchment scale provides a discrete hydrologic unit that allows for targeted stormwater management and monitoring. Five of the ten largest hydrologically-connected impervious areas within the watershed are included in the following recommendations as priorities for structural stormwater retrofits.

The structural retrofits recommended in this plan represent some of the best opportunities for restoration within the watershed and their implementation will manage some of the largest single stormwater discharges into Long Creek and its tributaries. This structural stormwater retrofit management approach will address up to 150 acres out of 640 acres of impervious area within the watershed. While these recommended retrofit opportunities have the potential for reduction of polluted stormwater discharges to Long Creek, additional survey and engineering evaluation will be needed to determine the final water quality and quantity treatment level. Additionally, the implementation of these structural retrofit recommendations does not guarantee that Long Creek and its tributaries will meet water quality classification standards in light of the multiple impacts of development discussed in Section 3 and their complex interactions. These recommendations should be read in combination with recommendations set out in 5.3. and 5.4. Structural retrofit priorities and other restoration priorities will be re-evaluated as appropriate to allow for consideration of other opportunities identified in cooperation with landowners, including opportunities associated with redevelopment, new technologies, grant funding and research conducted in the watershed and elsewhere[2].

Planning level cost estimates were developed for individual stormwater retrofits and cost summaries are included for each priority catchment as described below. The cost estimate worksheet used as a basis for structural management retrofit costs is included in Appendix 7.

Within priority catchment areas, structural stormwater management recommendations have been separated into three tiers to allow for an adaptive management approach as described in Section 6.

- **Tier 1** addresses retrofit opportunities that have very good cost-benefit ratios, have minimal impact on existing infrastructure (e.g. parking areas, pavement, etc.) and would be most likely to provide a significant reduction in polluted stormwater discharges.
- **Tier 2** addresses field identified opportunities that have average cost-benefit ratios, minimize impact on existing infrastructure, and are likely to provide additional water quality benefits beyond those proposed in Tier 1.
- **Tier 3** addresses the remaining impervious area within each catchment that is not managed under Tier 1 and Tier 2. Tier 3 recommendations typically have lower than average cost to benefit and

2 *February 2009, MDOT was approved to use federal stimulus funding to address stormwater impacts in the Long Creek Watershed. This is an excellent opportunity that will provide treatment to ~5.2 acres of highway impervious cover and ~ 30.2 acres of private property impervious cover. The three projects are detailed on page 154 in Appendix 8.*

may require significant modifications to paved areas and other infrastructure. Tier 3 recommendations are only likely to be required if Long Creek continues to fail water quality criteria after completion of various structural, non-structural, riparian, in-stream and geomorphic enhancement projects.

Table 5b provides estimated costs for the specific structural management recommendations detailed in Appendix 8. The average cost per impervious acre treated under this approach is $38,000. In some catchments, non-structural strategies were deemed to be more appropriate and cost-effective and are therefore recommended in place of structural retrofits.

Summary figures detailing key catchment characteristics, brief descriptions of tiered treatment scenarios, cost estimates and other relevant considerations were developed for each priority catchment recommended for restoration. Each of these is presented at the end of this section (beginning with Figure 5c on page 52).

Table 5b. *Cost estimate summary for tiered structural retrofit opportunities by MEDEP catchment.*

DEP Catchment #	Tier 1	Tier 2	Tier 3 (if necessary)	Total
E-34	$85,000	$88,000	$183,560	$356,560
E-24	$745,000	$55,500	$0	$800,500
A1-03	^	$112,000	$416,520	$528,520
A1-14	$46,500	$116,000	$135,000	$297,500
A1-05	$460,000	$165,000	$0	$625,000
C-11	$222,000	TBD	$705,640	$927,640
E-02	^	$165,000	$123,000	$288,000
B-21	$175,000	$94,000	$533,000	$802,000
C-08	$130,000	$35,000	$1,913,080	$2,078,080
Totals:	**$1,863,500**	**$830,500**	**$4,009,800**	**$6,703,800**
	^ Tier 1 addressed through redevelopment requirements			

5.3 Non-structural Management Opportunities for the Built Environment

This plan defines stormwater Best Management Practices (BMPs) as technology and education based controls that reduce the discharge of pollutants from impervious surfaces and developed land areas. Non-structural BMPs generally refer to operational activities and complimentary educational measures that are employed to reduce the release and discharge of pollutants. For the purposes of this plan, non-structural BMPs refer to stormwater runoff management techniques that do not require extensive construction efforts and either limit the generation of stormwater runoff or reduce the amount of pollutants contained in the runoff. In long-term watershed management programs, the EPA promotes the use of non-structural BMPs to focus on the need for pollution prevention rather than treatment (Muthukrishnan, EPA/600/R-04/184). However, watershed management plans often do not emphasize the importance of non-structural BMPs in overall restoration efforts (Clar, EPA 600/R-03/103). The EPA recommends that a comprehensive urban stormwater management plan includes the implementation of a combination of non-structural and structural BMPs for existing and new development to ensure long-term restoration success.

This plan considers there to be three primary components of non-structural BMPs:

1. Land use planning and standards promoting design of construction processes that minimize or eliminate adverse stormwater impacts;
2. Good housekeeping measures aimed at minimizing exposure and release of pollutants; and,

3. Targeted education and training to promote adoption of the previous two components.

Recommendations offered below for each of these three non-structural BMP components are based on watershed characteristics, expected reliability, implementation potential, and anticipated community and environmental acceptance.

5.3.1 Land Use Planning Recommendations

Land use planning plays an important role in watershed management and restoration (Muthukrishnan, 2004). The American Rivers report on Local Water Policy Innovation (Denzin, 2008) expresses the importance of local planning solutions for stormwater pollution based on the following:

- Local governments have the experience and authority to regulate land use;
- The site plan review process is ideal for stormwater regulations;
- Local governments can remove barriers to Low Impact Development (LID) and as local experience is gained with LID practices, policies should be expanded to require LID design where appropriate;
- Local action is vital to the Federal Clean Water Act permitting system; and
- Individuals have the power to make changes at the local level.

There are a variety of planning tools available to address stormwater management issues as summarized below.

Planning Toolbox 1: Implement Code, Zoning and Design Guidelines Revisions

The Long Creek watershed includes land area within four municipalities. Currently developed land is primarily in the South Portland and Westbrook portions of the watershed. Portland has minimal watershed land area available for development, while Scarborough has limited existing development within the watershed but potential opportunities for residential/commercial growth. These development opportunities highlight the relevance of the following restoration tools, some combination of which will be essential for future Long Creek water resource protection.

- *Consider exceeding MEDEP Chapter 500 stormwater thresholds for new development.* Sites with less than 1 acre of impervious surface can contribute to stormwater pollution but are not currently required to provide post-construction stormwater management. In the South Portland portion of the Long Creek watershed, over 50% of all parcels contain less than one acre of impervious cover. To provide increased protection from stormwater pollution, parcels smaller than 1 acre could be required to provide some level of treatment for stormwater runoff from impervious surfaces (e.g. detain and filter 0.5 inch of runoff from on-site impervious surfaces) and more flexible design standards for stormwater treatment systems could be allowed to maximize designer opportunities and minimize cost.

- *Modify and/or clarify redevelopment stormwater management requirements.* The Center for Watershed Protection identifies the establishment of stormwater management standards for redevelopment projects as the single greatest mechanism for long-term watershed improvement (CWP Manual 3, 2007). Current state stormwater management law does not comprehensively require redevelopment projects to meet stormwater management standards upon project completion. Modifying local code or redevelopment definitions to require stormwater management on projects that alter existing drainage infrastructure, change traffic patterns or convert existing land use on a given parcel would greatly aid in the long-term improvement and protection of the Long Creek watershed. Conversely, establishing a threshold based on the difference in stormwater runoff volumes before and after the completion of redevelopment projects to determine when stormwater treatment systems should be required will not provide the same level of improvement or protection.

- *Modify local code, design standards and guidelines to incorporate LID techniques.* A 2008 national study by American Rivers indicates that architects, developers and builders have cited existing code standards and requirements as the primary barrier to using and applying Low Impact Development (LID) techniques on new and redevelopment projects. The basis of LID techniques is the minimization of impervious surfaces on a developed site. The following recommendations are based on an evaluation of South Portland, Scarborough and Westbrook's zoning and code requirements (see Section 4).

  ◊ *Reduce off-street parking requirements.* Consider minimums based on LID guidance for particular zones and actual parking needs as identified in the Parking Generation report of the Interstate Transportation Engineers. Allow further reductions in parking for shared parking lots, parking near transit stops and compact car only options.

  ◊ *Allow peak demand overflow parking to be developed using pervious pavement technologies.* Modify pavement cross-section design standards to allow for pervious pavement design.

  ◊ *Reduce the minimum parking stall dimensions requirement.* Allow the use of 9' by 18' for regular parking stall dimensions and 8' by 16' for compact car spaces.

  ◊ *Reduce mandatory road widths.*

  ◊ *Expand the use of alternative transportation by requiring bicycle and pedestrian infrastructure for all new and redevelopment projects.*

  ◊ *Allow open drainage in appropriate locations or at a minimum promote or allow the use of curb breaks for drainage from curbed roadway.*

  ◊ *Allow or promote the separation of and beneficial reuse of rooftop runoff.*

  ◊ *Allow or promote stormwater management within required setback areas.* Landscaping design guidelines and required planting densities should be consistent with plantings for stormwater management systems. Review design guidelines or requirements and enhance consistency with appropriate structural BMPs. Promote full-size trees and tree planting locations on developed sites that will create the greatest potential for shading of impervious areas.

  ◊ *Consider zone or development parcel specific stormwater master planning.* Municipal Identification of specific locations within a developed area that could be used as a shared (multi-parcel) treatment system. Shared systems will enhance parcel by parcel stormwater management and minimize costs for developers. Parcel specific stormwater management systems can be more costly and less effective than shared stormwater management systems.

- *Implement transportation demand (TDM) strategies to decrease the use of single occupant vehicles.* Broadly, TDM is the application of strategies and policies to reduce automobile travel demand. In addition to decreasing the impacts from the pavement needed to provide "car habitat," TDM offers other multiple benefits, including reduced traffic congestion, road and parking facility cost savings, crash cost savings, consumer cost savings, air pollution reduction, and more efficient land use (Litman, 2008).

- *Implement parking demand strategies to reduce the need for existing and future paved parking facilities.* Cost-effective parking management programs can usually reduce parking requirements by 20-40% compared with conventional planning requirements, providing many economic, social and environmental benefits (Litman, 2008).
- *Consider market incentives for enhanced stormwater management.* These could include tax incentives for infill redevelopment, LID designs and structured or shared parking lots. Some communities create non-monetary incentives through expedited site plan review for "green" or LID designs.
- *Reference MaineDOT Waterway and Wildlife Crossing Policy and Design Guide, 3rd Edition (2008) within the municipal design standards for new culverts and stream crossings.*
- *Develop and enhance shoreland zoning regulations for all watershed streams as defined by state criteria and use as a basis for shoreland zone setback standards.*
- *The MEDEP should consider adjusting Chapter 500 general standards requirements for rooftop runoff in order to promote the separated management and treatment of these impervious surfaces. Allow green roof installations (meeting basic design criteria) to provide 100% of the required stormwater management for roof areas.*

Planning Toolbox 2: Implement Long-Term Planning Committees/Considerations

The Long Creek watershed will continue to experience an increase in roads, commercial areas and other developments. Therefore, the Watershed Restoration Project should focus on long-range planning needs. The following represent watershed land use issues identified through the Long Creek planning process that may require specific action for long-term watershed management plan success.

- *Develop a long-term strategy for large public and private snow storage.* Winter snow storage and subsequent runoff is likely to be a significant contributor to chloride violations. Unfortunately, chlorides are not treatable by any stormwater structural BMP. Consider development of a subcommittee focused on the resolution of snow storage issues for the private snow dump on County Road in Westbrook, the Portland snow storage facility on Outer Congress St., and snow storage areas in the Maine Mall parking complexes. Initially, this subcommittee should identify the actual impacts of these sites on stream chloride concentrations via water quality monitoring. Representatives from Casco Bay water quality monitoring organizations, Maine Department of Transportation Environmental Office and municipal public works should be included in the subcommittee.
- *Continue ongoing dialogue with the Maine Turnpike Authority on Turnpike expansion.* Developing a process to address potential issues related to turnpike expansion through the Long Creek watershed in cooperation with MTA planning staff. In addition to managing new stormwater runoff from expansion, future expansion projects should also address existing stormwater runoff from the Maine Turnpike into Long Creek.

- *Coordinate restoration activities with Portland International Jetport.* Future expansion of the Jetport may impact Long Creek. Conversely, no-build flyover zones in the watershed may play a central role in the conservation efforts recommended in Section 5.4. Present the Watershed Management Plan to the Portland Jetport planning staff.

- *Coordinate restoration activities with South Portland Land Trust (SPLT) concerning Stream Corridor Conservation Easements/Greenspace Corridor.* Portions of the Long Creek watershed area have been identified by the South Portland Land Trust as future trail corridors. The Watershed Restoration Project should facilitate the coordination of conservation corridor development and streamside vegetative enhancement with public access and trail development.

Planning Toolbox 3: Refine and Complete Long Creek Watershed Stormwater Drainage Map

A comprehensive understanding of urban hydrography is the foundation of effective long-term stormwater management. The current infrastructure mapping efforts in Long Creek have been primarily initiated by municipalities related to municipal infrastructure. Consider refining the current hydrography spatial dataset to include improved catchment boundaries, all open and closed drainage systems regardless of ownership, and existing detention and post-construction stormwater management facilities. Mapped drainage systems should be developed with automated network analysis considerations to allow for future hydrologic modeling.

5.3.2 Pollution Prevention and Good Housekeeping

There are four primary types of pollution prevention and good housekeeping tools that can help to minimize polluted stormwater runoff from impervious surfaces. These include:

1. Pavement sweeping;
2. Materials substitution and management;
3. Landscaping management; and
4. Private facility inspection and maintenance program

The following tools provide both general guidance and specific programmatic recommendations for public and private good housekeeping and pollution prevention efforts.

Pollution Prevention Toolbox 1: Pavement Sweeping

Sweeping all paved surfaces weekly may not be realistic for many facility or municipal managers but a targeted sweeping program will improve stormwater quality. A targeted sweeping program will require coordination among watershed landowners, municipal managers and state transportation agencies for development and implementation. Considerations in establishing a pavement sweeping program to reduce stormwater pollutant loads include:

- *Develop a targeted watershed street and parking area sweeping program*. In order to maximize limited financial resources, the Watershed Restoration Project should develop a targeted pavement sweeping program. A targeted program would identify and sweep the paved surfaces in the watershed that are most likely to contribute to stormwater pollutant loads. Traffic level, pavement condition, and land use types are considered key factors contributing to pollutant loads from paved surfaces. In order to address these pollutants via a street sweeping program, the Project should consider an assessment of watershed paved surfaces. At a minimum, this study should consider:

  - ◊ Directly-connected impervious areas;
  - ◊ Traffic data;
  - ◊ Visual assessment and quantification of parking use in commercial areas;
  - ◊ General pavement condition evaluation; and
  - ◊ A comprehensive inventory of land-use hot spots.

- The use of low-cost hydrocarbon absorbing catch basin inserts or outlet hoods at small parcel hotspots (e.g., gas stations or fast food drive-thru establishments) could also be an effective part of the targeted sweeping and pollutant reduction program.

Pollution Prevention Toolbox 2: Materials Substitution and Management

- *Winter salt alternatives:* To help address water quality impairment issues stemming from excessive chloride, the Watershed Restoration Project should consider developing an outline for a research program to identify winter deicer alternatives and their cost and benefits for commercial and municipal use. The outline should be submitted to Maine DOT, MTA and other regional research institutions for funding support and who are currently engaged in similar research on application and production of deicer alternatives.

- *Appropriate resurfacing sealants:* To reduce the potential for transport of high levels of petroleum hydrocarbons into Long Creek, the Watershed Restoration Project should consider working with contractors that apply coal-based tar sealants to determine if materials substitution is possible. Asphalt-based sealants should be considered first for all applications within the watershed. Good housekeeping reporting should require reporting on asphalt sealing activities. Ultimately, municipalities may want to consider prohibiting the future use of coal-based tar sealants on impervious surfaces in the watershed.

- *Pollution prevention:* The Watershed Restoration Project should research and develop outreach materials outlining appropriate management and handling of toxic materials on private property. The Project should consider training programs for private facility managers on materials substitution and toxics handling strategies to reduce stormwater exposure. Similar programs and outreach materials are being utilized in state industrial and municipal stormwater permitting programs.

Pollution Prevention Toolbox 3: Landscape Management

The Watershed Restoration Project should consider developing a training program for local landscaping contractors on appropriate management practices. This program would include, at a minimum, materials handling protocol, soil testing methods and requirements prior to fertilizer application, integrated pest management for reduced pesticide use, and soil structure enhancement for reduced pervious area runoff. Additionally, facility managers should be provided with materials outlining the necessity and benefits of shade for parking surfaces relative to stormwater quality and infrastructure longevity.

Pollution Prevention Toolbox 4: Private Facility Inspection & Maintenance Program

Private commercial facilities should provide annual documentation of good housekeeping, maintenance and inspection for stormwater infrastructure, pavement and post-construction BMPs. Good housekeeping reporting would include, at a minimum, dumpster location and management, hazardous materials handling and storage, landscape management BMPs, pavement sealing schedule and materials, winter deicer applications and pavement shading efforts. Annual maintenance requirements would include catch basin cleaning, pipe inspections and stormwater post-construction BMP maintenance if necessary. Inspection requirements would include stormwater management infrastructure and outfall stability evaluations. The Watershed Restoration Project should consider developing; (1) appropriate educational materials and training for private facilities participating in the program, (2) inspection training in order to develop an approved inspection contractor list, (3) inspection program checklists and (4) a multi-municipal web-based reporting system for ease of data entry and compliance documentation by the Watershed Restoration Project.

As an initial task for this program, the Watershed Restoration Project should initiate a watershed-wide review of existing post-construction management systems. This review would build upon the previous parcel file assessment conducted in 2006 by the South Portland Planning Department and would include field evaluation of current post-construction management systems. This evaluation will establish the base criteria for a BMP-credit system and will provide an informal audit identifying the needs for other good housekeeping training tasks.

5.3.3 Education and Training

- *Consider development of a stormwater grant program for private management efforts.* Non-priority structural retrofits may provide benefit to Long Creek and could be promoted through incentives. A small, competitive seed grant program for structural retrofits early in plan implementation may offer enough incentive for landowners to consider implementation during other capital improvements. Overall retrofit inventory results should be used as a basis for determining prospective grantees. The implementation efforts should be highlighted and provide a basis for non-priority demonstration projects within the watershed.
- *Develop a Long Creek stewardship program.* Develop Long Creek Restoration logo and install stream identification signage. Develop and begin implementation of "Business Stewards of Long Creek" program to recognize businesses that adopt sustainability practices in their operations. Install ongoing demonstration signage. Expand website to include facility manager training and stewards program certification.

5.4 Restoration Opportunities for the Aquatic Environment

As described in Section 3, the primary reason that Long Creek and its tributaries fail to meet water quality classification standards is the excessive amount of IC and other developed land uses in the watershed that result in unhealthy aquatic habitat conditions. While the structural and non-structural restoration practices described in Sections 5.2 and 5.3 will greatly aid in the recovery of the Long Creek watershed, restoration measures must also be employed for the aquatic environment. More specifically, improvements must be made to riparian and in-stream habitats while also reversing some of the damaging effects to the watershed's uplands and floodplains. Establishing the habitat conditions needed for the re-colonization of Long Creek and its tributaries by aquatic species more indicative of a healthy Maine stream (e.g., pollution-sensitive macroinvertebrates and brook trout) can only be accomplished through a holistic approach that integrates structural and non-structural restoration practices with those focused more directly on improvements to the aquatic habitat.

A summary overview of recommended riparian habitat, in-stream habitat, geomorphology, and other restoration projects located throughout the Long Creek watershed is presented in Table 5b and Figure 5b (pages 50 and 51, respectively). Most projects consist of multiple types of restoration work that should be completed concurrently. This grouped approach is similar to the one recommended for structural retrofits since it will minimize disturbance to a given project area; allow for greater economies of scale by reducing mobilization and materials costs; and provide more visible and substantive improvements to the watershed in comparison to a site by site approach, which can take several years to complete. Because most of the development in the Long Creek watershed occurs several meters above the stream channels and forested floodplains, a unique opportunity exists to complete stream restoration projects in highly visible areas without the risk of adjacent property damage.

MEDEP staff and Field Geology Services used best professional judgment to rank priority riparian, in-stream habitat and geomorphology restoration projects. (In 2008, MEDEP also used a protocol employed by other Maine resource management and protection agencies to assess the condition of culverts in much of the Long Creek watershed (USFWS, 2007)). Projects requiring significant riparian revegetation were assigned the highest priorities since the restoration of these areas will provide both near-term and long-term benefits. They will also play an important public education and outreach role as demonstration projects given their high visibility.

Projects requiring large wood and / or boulder additions were assigned a secondary priority only due to the fact that most of them are downstream of priority structural retrofit catchment areas, which need to be addressed before in-stream restoration occurs to provide the best overall opportunities for success. (Installing large wood and boulders before reducing stormwater runoff volumes through structural retrofits increases the risk of washing these features downstream during storm events). The next priority was assigned to floodplain (geomorphic) restoration projects, which will be critical to the overall improvement of the Long Creek watershed by reducing velocity of flows and capturing excess sediments, but will also present the highest costs to complete (on a linear foot basis) and provide limited public visibility.

Other types of restoration were ranked lower, though will also be very important in moving Long Creek and its tributaries towards attainment of water quality classification standards. They will also help promote public stewardship programs to protect and sustain the watershed over the long term. These include:

- Establishing conservation easements for the long-term protection of riparian, stream, and floodplain habitats (while also potentially providing public access and trail development);
- Development of a long-term stream corridor protection and management strategy (for riparian vegetation, large wood, floodplains, trails);
- Culvert maintenance, enhancement, or replacement;
- Invasive terrestrial plant control and native re-plantings; and
- Trash clean-ups.

All restoration work listed above is critical for successful stream restoration. The prioritization scheme used here is designed to ensure that no restoration actions will be attempted in downstream areas still subject to stream flows in excess of normal.

Table 5c: *Summary of in-stream habitat, riparian habitat and floodplain (geomorphic) restoration recommendations*

Project Name / Priority	Additional Project Details	Riparian Vegetation Restoration	Wood / Boulder Addition	Geomorphic Restoration (Floodplain / Streambank)	Conservation Easement	Culvert Replacement or Modification	Invasive Terrestrial Plant Control	Long-term Stream Corridor Management Plan	Estimated Stream Restoration Length (ft)	Estimated Project Cost
1. Goodyear Branch (a.k.a. Blanchette Brook)	Colonel Westbrook Executive Park region	X	X					X	2245	$152,619
2. Upper Long Creek	Sable Oaks region up to Spring St; main stem above confluence with Goodyear Branch	X	X					X	2640	$63,013
3. South Branch (upper)	Channelized section paralleling Philbrook Ave	X						X	2180	$105,419
4. Lower Long Creek "B"	From Foden Rd mid-way to Turnpike		X	X			X	X	1415	$232,500
5. North Branch (lower)	From main stem confluence to Foden Rd		X					X	1030	$19,500
6. Middle Long Creek	Main stem from confluence with Goodyear Branch to Turnpike		X		X			X	4470	$19,500
7. Lower Long Creek "C"	From Turnpike mid-way down to Foden Rd	X	X					X	1105	$41,815
8. Lower Long Creek "A"	From Foden Rd down to Clark's Pond		X	X				X	2970	$250,500
9. South Branch (lower)	Primarily within Clark's Pond retail shopping area		X			X	X	X	3220	$339,500
10. North Branch (middle)	Section immediately upstream of Foden Rd		X			X		X	740	$24,500
Stream Corridor Management Plan										$40,000
								Totals:	**22015**	**$1,288,866**

Appendix 2, pages 96-98, provides the breakdown of these cost estimates. In addition, the $19,500 cost listed for project 6, Middle Long Creek, only represents the recommended wood and boulder addition. The cost of conservation easements is unknown and will need further research to determine.

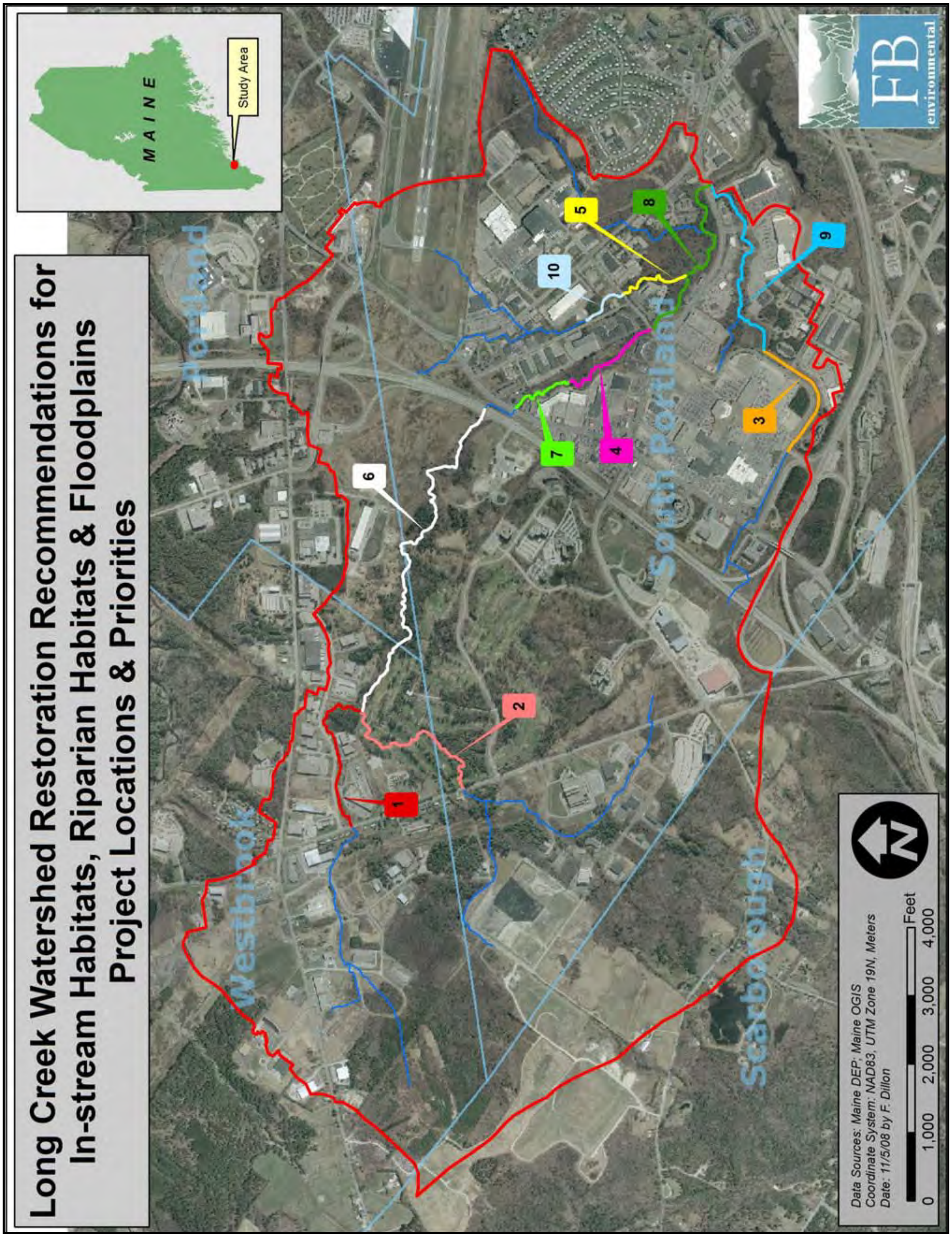


Figure 5b: *Locations for in-stream habitat, riparian habitat and floodplain (geomorphic) restoration projects*

CATCHMENT E-34

Catchment Characteristics

DEP ID E-34
Size 11 acres

Impervious Cover Breakdown
Rooftop 24% (2.4 acres)
Parking 67% (6.7 acres)
Roadway 9% (0.9 acres)
Existing Stormwater Management System - Yes
Stormwater Infrastructure Ownership - Private

Opportunity Overview –

Tier 1: Expand and enhance the Hannaford Shopping Plaza's existing stormwater detention basin to provide improved water quality treatment.

Tier 2: Locate water quality filters in greenspace portions of the parking lot and loading dock area for additional levels of water quality treatment.

Tier 3: If necessary, install above or below grade filters to bring the catchment up to current stormwater standards.

Tier	Retrofit ID#	Estimated Cost
1	SPO_038	$85,000
2	SPO_028 SPO_037 SPO_036 SPO_035	$88,000
3	Below grade storage	$186,000

Considerations

The current wet pond diversion structure may require reconfiguration or reconstruction for the new stormwater management system. Soil Filter SPO_036 would likely require some tree removal and drainage easement acquisition.

Figure 5c: *Catchment E-34 locations, types and tiered cost summaries for structural retrofits.*

CATCHMENT E-24

Catchment Characteristics

DEP ID E-24
Size 66 acres
Impervious Cover Breakdown
Rooftop 24% (14 acres)
Parking 75% (45 acres)
Roadway 1% (0.6 acres)

Existing Stormwater Management System - Yes
Stormwater Infrastructure Ownership – Private w/minor municipal component

Opportunity Overview

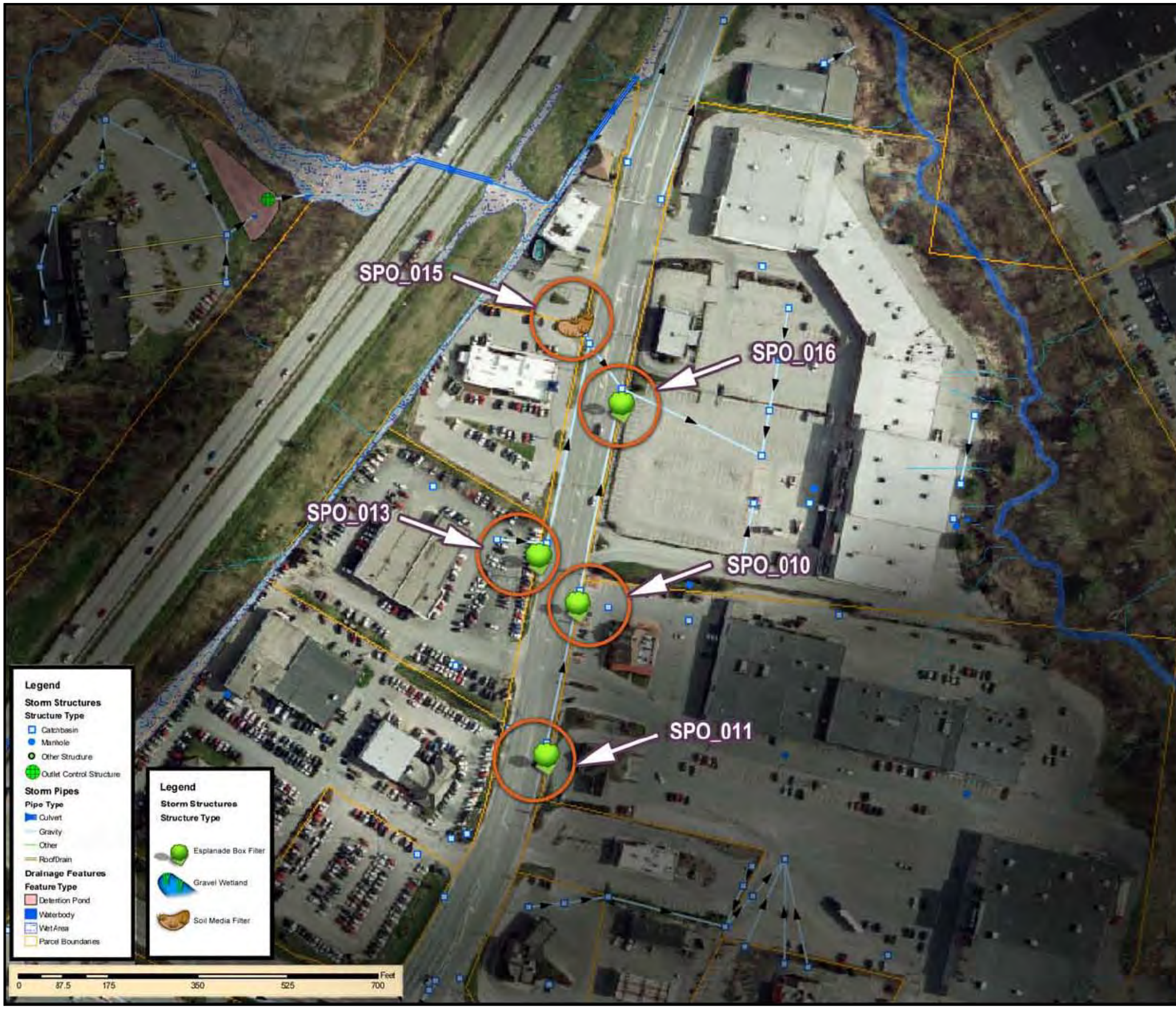
Tier 1: Expand and enhance the two dry detention basins at the outlet of each stormwater drainage system to provide improved water quality treatment.
Tier 2: Locate additional water quality filters in setback portion along Philbrook Ave to manage municipal contribution in this catchment. A small demonstration raingarden could be located near north entrance to Macy's in current concrete median if soils are deemed to be appropriate.
Tier 3: Enhance drainage plan maps and provide additional retrofits as needed to maximize value of SPO_034.

Tier	Retrofit ID#	Estimated Cost
1	SPO_034, GGP Wet Pond	$745,000
2	SPO_030 SPO_089	$55,500
3	TBD	$0

Considerations

Discrepancies and missing data on storm drain infrastructure maps should be rectified prior to design. SPO_034 may require expansion in order to accommodate 0.5" of water quality volume. Soil Filter SPO_030 may require drainage easement acquisition. GGP Wet Pond retrofit based on previous design under GGP Stormwater Master Plan.

Figure 5d: *Catchment E-24 locations, types and tiered cost summaries for structural retrofits.*



CATCHMENT A1-03

Catchment Characteristics

DEP ID A1-03
Size 16 acres
Impervious Cover Breakdown
Rooftop 27% (3.8 acres)
Parking 63% (9.1 acres)
Roadway 10% (1.4 acres)

Existing Stormwater Management System – No
Stormwater Infrastructure Ownership – State and Private

Opportunity Overview

Tier 1: Enhance stormwater management within catchment through BMP requirements for private redevelopment along Maine Mall road.
Tier 2: Implement water quality retrofits along Maine Mall Road.
Tier 3: Implement below grade storage and filter system for runoff from Shoppers Village parking area.

Tier	Retrofit ID#	Estimated Cost
1	Redevelopment Requirements	N/A
2	SPO_010 SPO_011 SPO_013 SPO_014 SPO_015 SPO_016	$112,000
3	Parking Area Retrofits	$416,520

Considerations

Redevelopment within this catchment was identified as likely to occur over the next several years. Applicability and functionality of esplanade box filters on state highways in Maine should be assessed in demonstration locations prior to widespread implementation.

Figure 5e: *Catchment A1-03 locations, types and tiered cost summaries for structural retrofits.*

CATCHMENT A1-14

Catchment Characteristics

DEP ID A1-14
Size 8 acres
Impervious Cover Breakdown
Rooftop 11% (0.6 acres)
Parking 43% (2.5 acres)
Roadway 46% (2.6 acres)

Existing Stormwater Management System – No
Stormwater Infrastructure Ownership – State

Opportunity Overview

Tier 1: Enhance existing dry detention basin on private property to manage public and private stormwater runoff.
Tier 2: Implement water quality retrofits along Maine Mall Road.
Tier 3: Implement additional water quality retrofits along Maine Mall Road.

Tier	Retrofit ID#	Estimated Cost
1	SPO_064 SPO_063	$46,500
2	SPO_059 SPO_060 SPO_071 SPO_072 SPO_073	$116,000
3	SPO_061 SPO_062 SPO_065 SPO_070 SPO_074 SPO_098	$135,000

Considerations

Diversion of roadway runoff for Tier 1 retrofit will require sidewalk culvert or other shallow conveyance under sidewalk. Drainage easement and cooperation with private landowner will be required for this retrofit. Applicability and functionality of esplanade box filters on state highways in Maine should be assessed in demonstration locations prior to widespread implementation.

Figure 5f: *Catchment A1-14 locations, types and tiered cost summaries for structural retrofits.*

CATCHMENT A1-05

Catchment Characteristics

DEP ID A1-05
Size 14 acres
Impervious Cover Breakdown
Rooftop 25% (3.4 acres)
Parking 75% (10.3 acres)
Roadway 0% (0 acres)

Existing Stormwater Management System – No
Stormwater Infrastructure Ownership – Private

Opportunity Overview

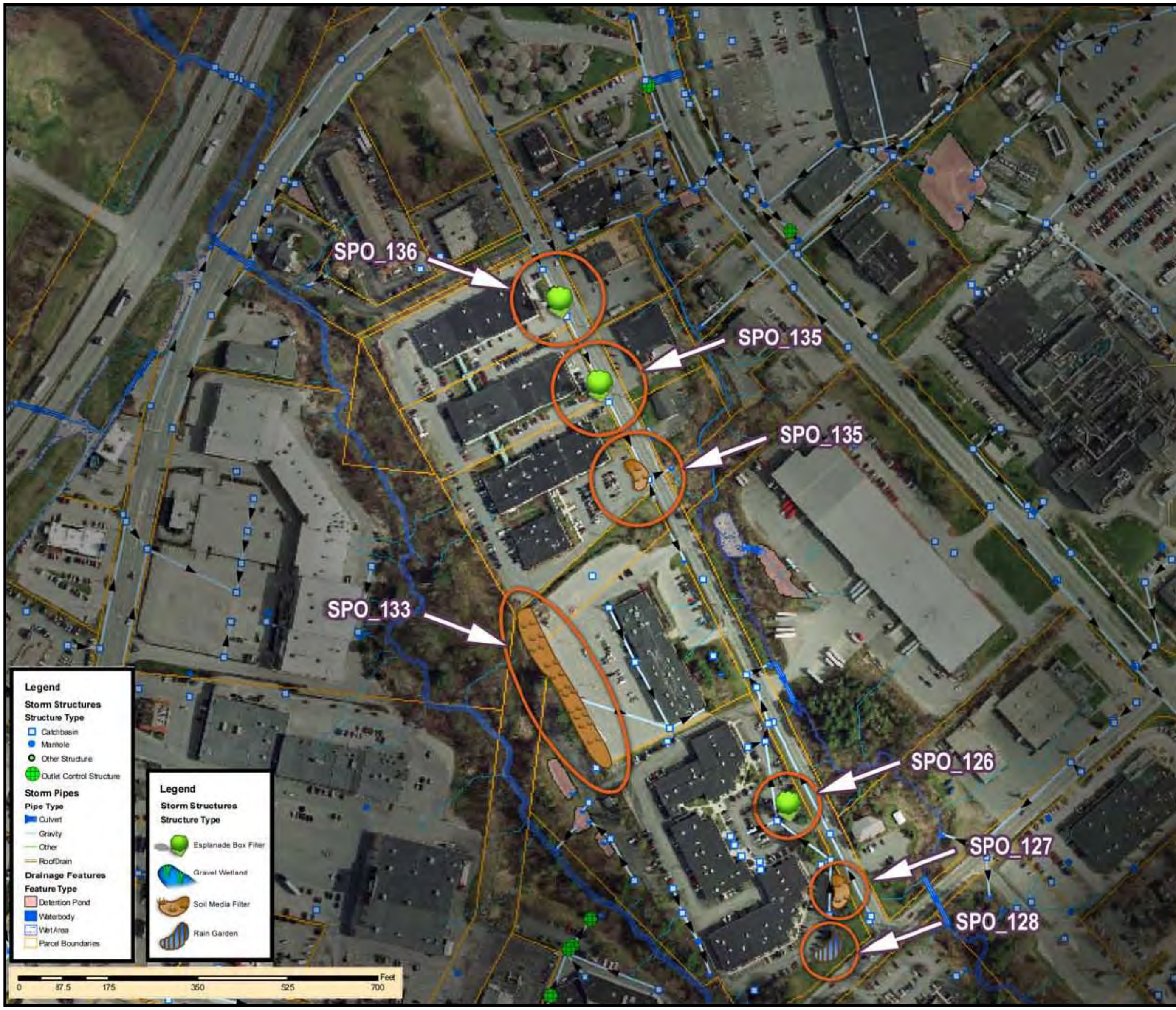
Tier 1: Provide "end of the pipe" below grade storage and filtration for primary catchment area. Include development of surface soil media filter during construction of below grade system in same location.
Tier 2: Implement additional water quality retrofits in other portions of catchment area to enhance function of Tier 1 system.
Tier 3: Integrate Tier 1 and Tier 2 designs to reach 1" treatment threshold for entire parcel. Install soil media filter for Dick's rooftop runoff (currently outside of catchment area).

Tier	Retrofit ID#	Estimated Cost
1	SPO_006 SPO_039	$460,000
2	SPO_001 SPO_002 SPO_003 SPO_005	$165,000
3	Integration of Tier 1 and Tier 2 SPO_007	$170,000

Considerations

Detailed survey and engineering evaluation of existing storm drain infrastructure near outlet will be necessary to determine appropriate options for stormwater treatment system in this area. SPO_005 assumes sufficient depth of adjacent storm drain to install a below grade water quality filter system.

Figure 5g: *Catchment A1-05 locations, types and tiered cost summaries for structural retrofits.*



CATCHMENT C-11

Catchment Characteristics

DEP ID C-11
Size 16.8 acres
Impervious Cover Breakdown
Rooftop 25% (2.8 acres)
Parking 59% (6.7 acres)
Roadway 16% (1.8 acres)

Existing Stormwater Management System – No w/some private systems prior to discharge to city storm drain.
Stormwater Infrastructure Ownership – Private and City

Opportunity Overview

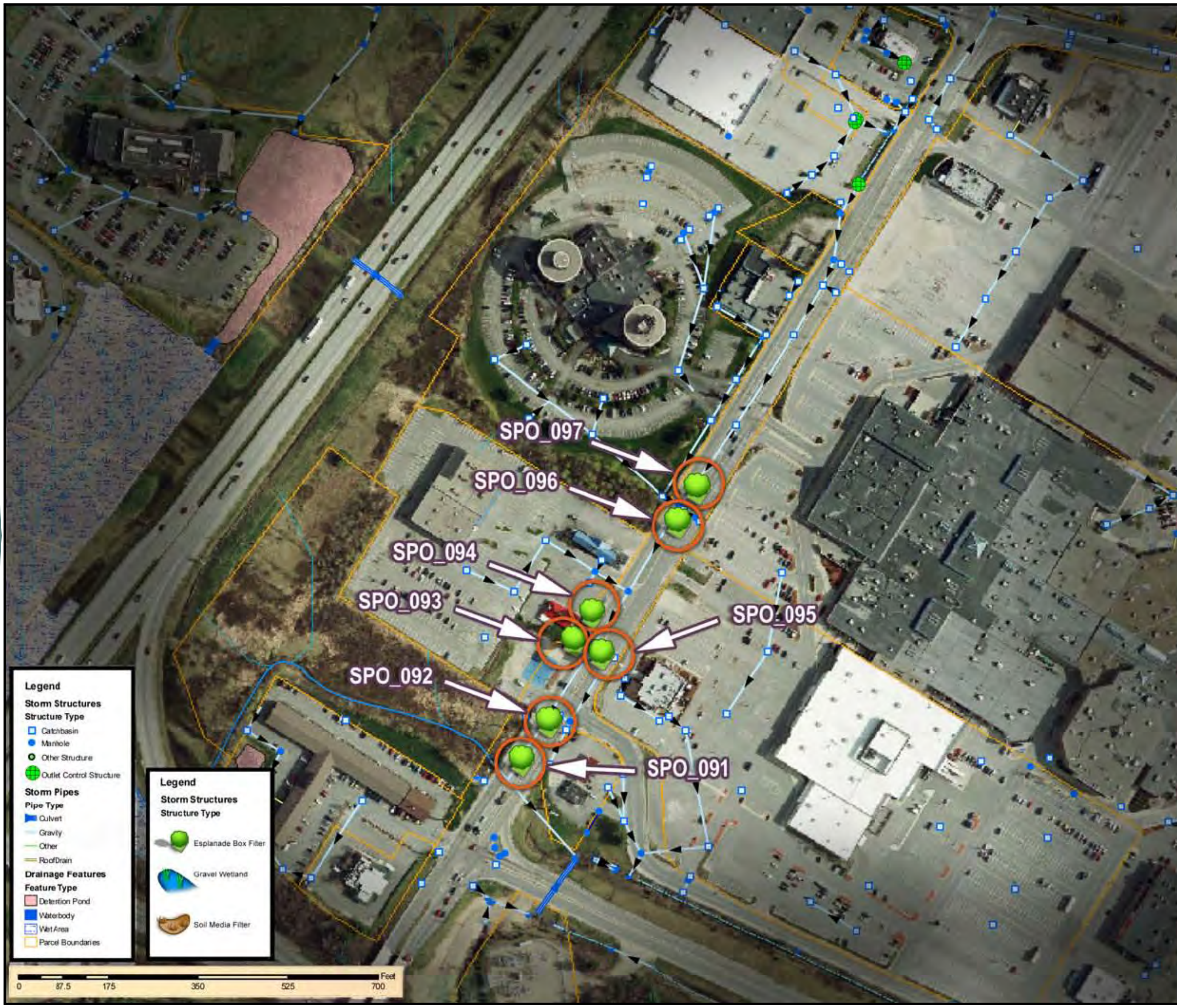
Tier 1: Implement water quality retrofits along Darling Ave and within private facilities along Darling Ave.
Tier 2: Implement Darling Avenue roadway shoulder and ditch/turnout enhancements to minimize erosion and sediment transport to North Branch of Long Creek.
Tier 3: Implement additional water quality retrofits for impervious cover within catchment.

Tier	Retrofit ID#	Estimated Cost
1	SPO_126 SPO_127 SPO_128 SPO_133 SPO_134 SPO_135 SPO_136	$222,000
2	Darling Ave. WQ Improvements	TBD
3	Additional IC WQ enhancements	$705,640

Considerations

Private drainage areas discharging to Darling Ave may require more than one esplanade filter box for capacity. Small stormwater management system exists on Parcel 48_013A and may provide sufficient management for parcel without SPO_133 retrofit.

Figure 5h: *Catchment C-11 locations, types and tiered cost summaries for structural retrofits.*



CATCHMENT E-02

Catchment Characteristics

DEP ID E-02
Size 17 acres
Impervious Cover Breakdown
Rooftop 22% (3.1 acres)
Parking 54% (7.8 acres)
Roadway 24% (3.5 acres)

Existing Stormwater Management System – No w/some private management prior to discharge to state road storm drain.
Stormwater Infrastructure Ownership – State w/private connections.

Opportunity Overview

Tier 1: Enhance stormwater management within catchment through BMP requirements for private redevelopment along Maine Mall road.
Tier 2: Install water quality filters in median and in roadway setback along Maine Mall Road. Install a linear gravel wetland in the open ditch in front of Toys 'R US/Office Depot property.
Tier 3: Install a series of wetland detention cells and realign stream in the 1000ft section of stream between Payne Road and Philbrook Ave access ramp.

Tier	Retrofit ID#	Estimated Cost
1	Redevelopment requirements	N/A
2	SPO_091-092, SPO_095-097; additional location	$197,000
3	N/A	$1,000,000

Considerations

Redevelopment within this catchment was identified as likely to occur over the next several years. For the stream realignment project, it is unknown if the entire 1000ft section will need to be retrofit. Hydraulic, hydrological, ecological and stormwater engineering studies still need to be completed.

Figure 5i: *Catchment E-02 locations, types and tiered cost summaries for structural retrofits.*

CATCHMENT B-21

Catchment Characteristics

DEP ID B-21
Size 33 acres
Impervious Cover Breakdown
Rooftop 27% (3.6 acres)
Parking 50% (7.8 acres)
Roadway 23% (3.6 acres)

Existing Stormwater Management System – Yes for one discharge within catchment
Stormwater Infrastructure Ownership – State, City and Private

Opportunity Overview

Tier 1: Implement water quality retrofit within existing dry detention basin on private property. Private system accepts runoff from private and public infrastructure.
Tier 2: Implement additional water quality retrofits for other primary discharge within catchment.
Tier 3: Implement additional water quality retrofits for impervious cover within catchment, including soil enhancement demonstration project for pervious commercial lawn areas.

Tier	Retrofit ID#	Estimated Cost
1	WB_007	$175,000
2	WB_002 WB_004 WB_001 WB_003	$94,000
3	Additional IC WQ enhancements	$533,000

Considerations

Tier 1 retrofit may require a bypass or upstream drainage area detention for this system to operate at full effectiveness. Limited hydraulic head may complicate some Tier 2 retrofit opportunity.

Figure 5j: *Catchment B-21 locations, types and tiered cost summaries for structural retrofits.*

CATCHMENT C-08

Catchment Characteristics

DEP ID C-08
Size 40 acres
Impervious Cover Breakdown
Rooftop 33% (10 acres)
Parking 66% (20 acres)
Roadway 1% (0.4 acres)

Existing Stormwater Management System – Yes
Stormwater Infrastructure Ownership – Private

Opportunity Overview

Tier 1: Implement water quality retrofit within existing dry detention basin on Fairchild Semiconductor property.
Tier 2: Implement additional water quality retrofits within other existing dry detention basins on National Semiconductor property.
Tier 3: Implement additional water quality retrofits for impervious cover within catchment.

Tier	Retrofit ID#	Estimated Cost
1	SPO_018	$130,000
2	SPO_019	$35,000
3	Additional IC WQ enhancements	$1,913,000

Considerations

Tier 1 retrofit will require a bypass for other stormwater drainage from National Semiconductor property through dry detention basin. Limited hydraulic head may complicate Tier 2 retrofit on National Semiconductor property.

Figure 5k: *Catchment C-08 locations, types and tiered cost summaries for structural retrofits.*

6. Methodology for Measuring Success

6.1 Adaptive Management Components

Adaptive management is the process by which new information about the health of the watershed is incorporated into the watershed management plan. An adaptive management approach is widely recommended for restoring urban watersheds (CWP, NSF paper). Adaptive management enables stakeholders to conduct restoration activities in an iterative manner (Figure 6a). This provides opportunities for utilizing available resources efficiently through BMP performance testing and ambient water body restoration monitoring activities. Stakeholders can evaluate the effectiveness of one set of restoration actions and either adopt or modify them before implementing effective measures in the next round of restoration activities. The adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short-time frame (e.g., 2 years). Rather, adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration activities. Implementation of this approach will ensure that required restoration actions are implemented and that Long Creek is monitored to document restoration over an extended time period. The adaptive management components for the Long Creek Restoration Project will include:

- *Synthesizing Restoration Actions.* This watershed management plan provides two sets of prioritized recommendations to support restoration (e.g., structural/non-structural recommendations for priority catchment areas and in-stream/riparian/geomorphic recommendations for improvements to

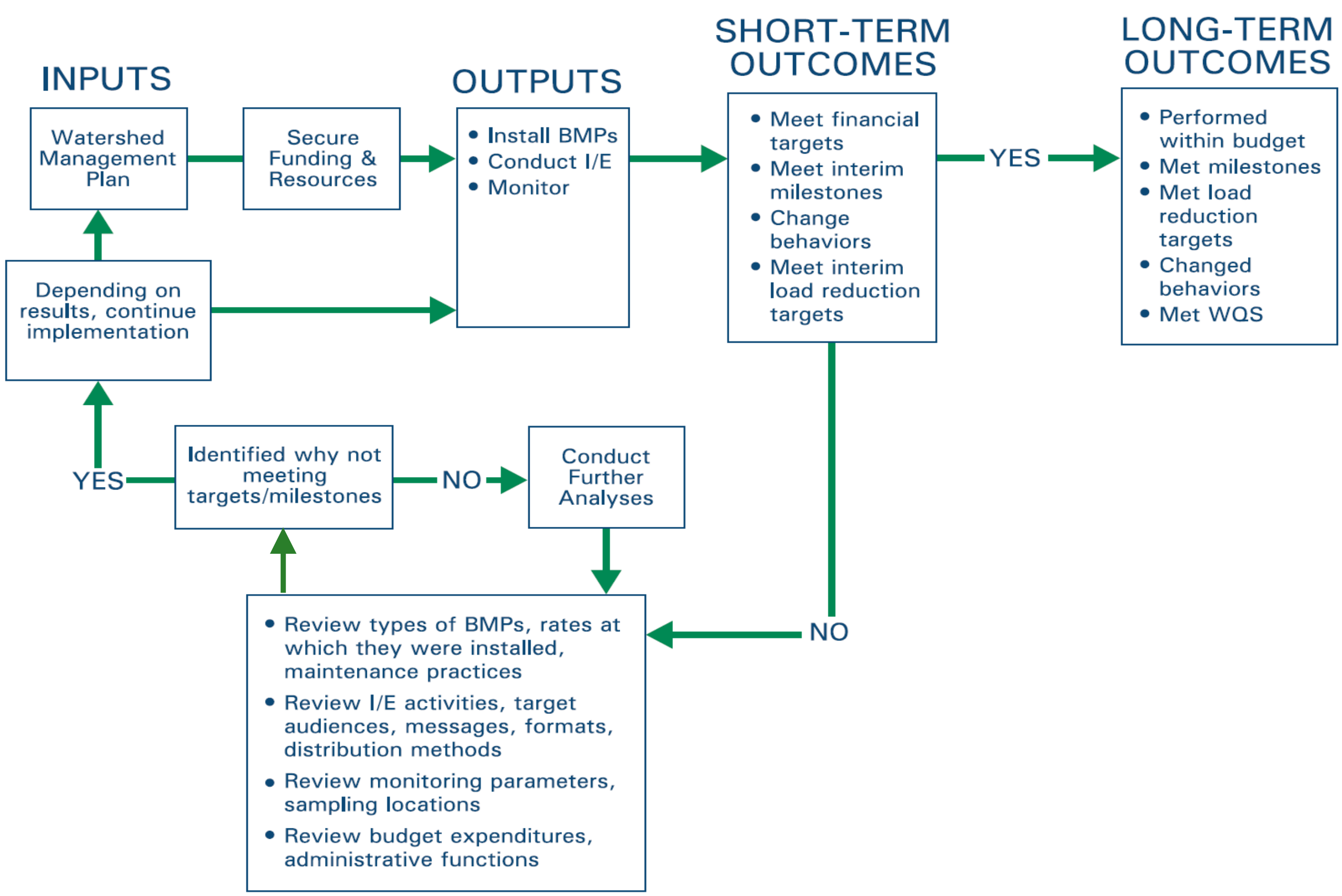


Figure 6a: *EPA adaptive management approach (EPA, 2008).*

specific priority stream segments). All recommendations were developed by the technical consultants and MEDEP in close consultation and collaboration with the Technical Advisory Committee (TAC) and other stakeholder committees (Steering and Models & Outreach Committees). These two sets of recommendations need to be synthesized to create a unified watershed restoration strategy. Once a funding mechanism is established, the restoration program should begin in earnest by developing detailed designs for priority restoration activities on a project area basis and scheduling their implementation accordingly. Structural retrofit priorities and other restoration priorities in the strategy should be re-evaluated as appropriate to allow for consideration of additional opportunities identified in cooperation with landowners, including opportunities associated with redevelopment, grant opportunities, new technologies and research conducted in the watershed and elsewhere.

- ***Developing a Field Monitoring Program.*** A field monitoring program is required to track the anticipated improvements to the aquatic health of the Long Creek watershed. Indeed, the overall goal of the watershed management planning process is the restoration of the aquatic health of Long Creek. Thus, monitoring aquatic health as restoration actions are implemented is critically important. The monitoring program will also provide the necessary feedback on the effectiveness of restoration practices at the catchment and subwatershed scales and will support optimization of restoration actions through an adaptive management approach.
- ***Establishing Criteria for Measuring Progress.*** Maine water quality criteria specify that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving water and maintain the structure and function of the resident biological community. Since impervious cover has been identified as contributing to the impairment of Long Creek's water quality, tracking the implementation of measures to address the impacts created by impervious cover will be a crucial part of measuring progress.
- ***Establishing Measurable Milestones.*** A restoration schedule that includes milestones for measuring the implementation of restoration actions and monitoring activities in the Long Creek watershed is critically important. Once the level of funding has been established to determine the extent of recommended action strategies that can be implemented each year, the Long Creek Management District governing board will need to revisit the projected schedule included in this Plan.

6.2 Monitoring Program

A well designed monitoring program is a critical component of the Long Creek Restoration Project since it will establish the relative effectiveness and success of restoration recommendations against pre-implementation (or "baseline") watershed conditions. To determine the specifics of the Long Creek monitoring program, the Casco Bay Estuary Partnership (CBEP) has formed a committee during the "program start up" period as discussed in Section 7.5. This committee consists of representatives from relevant organizations with water quality monitoring expertise. To the extent possible, the monitoring program should precede the implementation of restoration actions (to establish baseline conditions) and then continue concurrently throughout the duration of the project. The goals of the monitoring program should be two-fold. One goal should support the assessment of overall aquatic health of Long Creek over time; a second goal should support an evaluation of the effectiveness of restoration practices for improving the aquatic habitat on a catchment area and subwatershed basis.

Monitoring program results will be analyzed on an ongoing basis in order to optimize the restoration process by implementing the most effective mitigation actions. This plan recommends that numerous restoration actions, such as the installation of stormwater BMPs, should be implemented in groups for each relatively small catchment project area. This project area approach should allow for considerable savings as compared to installing stormwater BMPs on an individual basis. The goal of these grouped actions will be to make a relatively large positive impact on the local catchment area and a relatively smaller positive impact on the entire watershed. The monitoring program should include measurement of the local improvement associated with each mitigative measure and the cumulative positive impact of a set of many restoration actions implemented over time. Thus, the monitoring program will feature a two-tiered approach:

1. ***Ambient Long Creek Monitoring.*** An ambient stream monitoring program will support assessment of the overall health of the stream system; and
2. ***Catchment Area and Subwatershed Monitoring.*** A set of specific monitoring programs will support assessment of the performance of restoration actions.

For each type of monitoring program, a set of hydrologic, water quality and aquatic biological measurements that may be required to identify restoration success is provided below. It would also be useful to include periodic stream walks (perhaps every few years) to assess the condition of the riparian corridor in relation to adjacent land use change.

6.2.1 Ambient Long Creek Monitoring Program

An overall goal of the ambient monitoring program is to track the improvement of the watershed's overall aquatic health over time. A representative set of aquatic health indicators should in many cases be measured each year and changes in these indicators interpreted. After an initial, post-planting or post-construction monitoring project has occurred, some parameters might need to be measured only every 2-3 years due to costs and expected rates of recovery. These could include biological indicators (macroinvertebrates, fish, algae), riparian vegetation and geomorphological characteristics. The set of aquatic health indicators should include characteristics that have been degraded by the urbanization of Long Creek. Measuring these characteristics each year will support accurate assessment of the success of restoration actions in the watershed. The ambient monitoring program will likely include the following components:

- ***Hydrology*** via continuous stream flow measurements correlated with precipitation data;
- ***Water quality*** via continuous in-situ measurements and synoptic grab sampling and laboratory analysis for key water quality parameters;
- ***Biology*** via macroinvertebrate and fish surveys; and
- ***Riparian/floodplain/in-stream habitat assessment*** to determine extent of adjacent land use modifications and habitat improvements via parameters such as in-stream large wood abundance, habitat diversity measures, flow velocity heterogeneity, bank stability, etc.

The number of surveys, the locations and number of sampling sites, and the specific measurements collected will be determined by the monitoring committee (convened by the Casco Bay Estuary Partnership) as the goals of the monitoring program become clear based on available resources and funding.

The ambient monitoring program should commence prior to implementation of mitigation measures in order to establish directly comparable baseline conditions. After each year's sampling is completed, data will be analyzed and compared to data collected during previous years. This data collection program and data analysis and interpretation protocol will support assessment of progress in restoring Long Creek.

6.2.2 Catchment Area Site-specific Performance Monitoring

Restoration of Long Creek will require implementation of numerous catchment area best management practices (BMPs) to reduce the adverse impacts of these areas on the aquatic ecosystem. A goal of the catchment area performance monitoring program is to quantify the effects of each set of restoration actions. This monitoring program will serve to validate the positive impact of restoration and will support the process of optimizing effectiveness in future mitigation. For example, the types of BMPs that are observed to be highly effective will be used more in the future while less effective BMPs will be phased out.

A site-specific performance monitoring program for a stormwater BMP would potentially include measurement at the outlet of the catchment area for the following:

- Volumetric discharge rate throughout each of a set of storm events;
- Continuous recording of in-situ water quality parameters; and
- Automated grab sampling for analysis of a set of water quality parameters including suspended solids, nutrients, oil and grease, and metals during storm events.

Catchment area monitoring would be conducted prior to installation of BMPs in order to establish baseline conditions and following installation of BMPs to measure improvement in conditions.

6.3 Criteria for Measuring Progress

Maine water quality criteria for Class B and C waterbodies are outlined in Table 3a (page 18). Maine DEP placed Long Creek on the Section 303(d) list of impaired waters. The Creek currently does not meet State water quality standards due to increased concentrations of metals, chloride, phosphorus, nitrogen, polycyclic aromatic hydrocarbons (PAHs), and reduced dissolved oxygen concentrations that pose substantial nonpoint source (NPS) threats to Long Creek. Additional NPS threats include altered hydrological conditions and increased water temperatures from lack of shading in certain areas.

A direct correlation has been established between impervious cover and the health of aquatic ecosystems. It has been shown that as impervious cover increases above 10% there is a corresponding increase in stormwater flows and degradation in water quality, stream habitat, and diversity of aquatic life. Some areas of the Long Creek watershed have an impervious cover of greater than 60%. The goal of this plan is for Long Creek to meet State water quality standards by 2019. It is proposed that this will be accomplished by reducing the effective impervious cover by treating 150 acres with structural retrofits, implementing nonstructural measures to limit the impact of all impervious cover and implementing in-stream, riparian and floodplain mitigation to rehabilitate stream habitat.

The monitoring plan that will be overseen by LCMD in cooperation with CCSWCD, DEP, EPA and CBEP will outline parameters to assess whether Long Creek is meeting State water quality standards. It is anticipated that the implementation of this plan will result in associated pollutant load reductions as described in Appendix 9.

6.4 Measurable Milestones

The restoration strategy presented in the plan is an adaptive approach where the measures that are expected to provide the most benefit to the stream will be implemented first and the stream and its biota will be continuously evaluated to gauge the response. The goal is for Long Creek to meet State water quality standards by 2019 by completing the following milestones. Once funding mechanisms and a governing board have been established for the Long Creek Restoration Project, the list and schedule of measurable milestones will be revisited by the governing board.

By 2010, establish Long Creek Management District (LCMD) and the associated governing board.

From 2009 to 2015, revenue from participating public and private landowners will support plan implementation including, but not limited to:

- Installation of approximately $3,000,000 of on-the-ground structural retrofits to address approximately 75 acres of impervious surface and half of the identified priority in-stream, riparian and floodplain restoration sites (see page 78 for detailed implementation schedule projection);
- Implementation of watershed wide maintenance program including a targeted vacuum sweeping program and maintenance of installed best management practices;
- Education of watershed property owners regarding landscaping practices, winter maintenance and pollution prevention practices, and continuance of www.restorelongcreek.org website;
- Collaboration with municipal planners to work towards changes in municipal codes to support LID practices and provide stream protection; and
- Water quality and performance of installed measures will be monitored on an annual basis to determine progress and course corrections will be made, as appropriate.

By 2020, revenue from participating public and private landowners will support plan implementation including, but not limited to installation of approximately $2,000,000 of on-the-ground structural retrofits to address approximately 75 acres of impervious surface and the remaining identified priority in-stream, riparian and floodplain restoration sites, or equivalent (see page 78 for detailed implementation schedule projection) and continuation of management measures listed above.

From 2010 – 2019, water quality data will be assessed to determine whether and when Long Creek meets applicable water quality standards. It is anticipated that Long Creek will meet State water quality standards after implementation of Tier 1 and 2 structural retrofits and all ten identified in-stream habitat, riparian habitat and floodplain restoration recommendations or equivalent measures; establishment of targeted sweeping and BMP maintenance program; education of watershed property owners and managers regarding landscaping practices, winter maintenance and pollution prevention practices; and adjustments to municipal codes to support LID practices and provide stream protection. If this is not achieved then additional recommendations will be identified and a timeline for implementation will be developed.

6.4.1 Interim Milestones

Since it is anticipated to take at least ten years for Long Creek to meet State water quality standards, interim milestones may also be tracked to measure progress on Plan implementation. Some examples of potential interim measurable milestones for the Long Creek Watershed Management District to consider include:

Programmatic indicators that identify progress in administering the watershed management plan

- Amount of grant funding secured for plan implementation
- Number of structural BMPs installed and acres of IC treated by structural BMPs
- Number of structural BMPs inspected and maintained
- Number and types of non-structural restoration activities completed
- Acres of IC addressed by non-structural BMPs
- Changes to municipal ordinances for improved watershed protection

Environmental indicators that directly measure or relate to in-stream conditions

- In-stream pollutant load reductions (Appendix 9 provides an estimation of anticipated load reductions resulting from the implementation of recommended management measures)
- Macroinvertebrate type, abundance and distribution
- Reduction in duration and frequency of peak flows
- Linear feet of riparian habitat revegetated or protected from development
- Brook trout abundance (or absence)
-

Social indicators that measure behavioral changes in social or cultural practices leading to implementation of management measures and water quality improvement

- Number of business owners who participate in demonstration projects
- Number of watershed stakeholders (or contractors) who participate in educational programs
- Number of requests for information through project website

7. Implementing the Plan: Administrative and Funding Approach

A central challenge for any watershed restoration effort is to determine how to progress from planning to implementation. This requires identifying and creating the institutional structure to implement the plan, and addressing how the considerable work of restoration will be funded. The following section proposes an institutional framework to create a coordinated restoration program to undertake the work of restoring Long Creek and addressing its long-term water quality problems.

7.1 Relationship to ongoing and new regulatory requirements

In actions independent of the Long Creek Project's planning effort, regulatory agencies have announced that watershed landowners will be required to meet new, more stringent requirements to address water quality problems. Owners of individual parcels in the watershed with one acre or more of "impervious cover" - rooftops, parking lots and road ways - will be required to meet new regulatory conditions required by MEDEP, under a preliminary order from the Federal EPA. Stricter regulatory requirements will also affect municipalities and other public entities in the watershed. Beginning in 2009, all municipalities with land in the Long Creek watershed will be required to commit to taking significant steps to address stormwater impacts of town buildings and roads. New requirements will go into effect regardless of whether the Long Creek Restoration Project implements its collaborative plan. New regulatory requirements will augment existing stormwater standards set out in Maine regulations (Chapter 500). For a more detailed discussion of new and existing requirements, see Section 1.3.

The reality of impending new regulatory requirements has significantly influenced this planning process. The Long Creek Restoration Project has focused on developing a restoration plan that provides a better approach to meeting new regulatory requirements than parcel-by-parcel regulation. The Long Creek Restoration Project believes that the watershed management plan sets out a course of action that will be more effective in restoring the stream and less costly to landowners than parcel-by-parcel regulation.

There are other important reasons to develop a restoration plan. Restoring Long Creek is important to the health of Clark's Pond - once a popular place to swim and fish - and to the ecological health of the Fore River and Casco Bay. The collaborative plan can also have other important benefits, such as attracting private and federal dollars for green jobs and green infrastructure.

7.2. Why coordinated implementation will be more effective and less costly than the individual permit approach

Landowners with parcels in the Long Creek watershed with one acre or more of IC are expected to be required to obtain a Maine Pollutant Discharge Elimination System (MEPDES) stormwater permit (i.e., an individual or general permit) sometime in 2009, under a preliminary order by the Federal EPA. The Watershed Management Plan creates the opportunity to ask regulatory agencies to give landowners the option of participating in a coordinated program under a general permit in lieu of obtaining an individual permit. A restoration plan creates the opportunity to implement a coordinated program that will be more effective in restoring the stream and less costly for individual landowners than meeting conditions necessary for individual permits, for the following reasons.

First, stormwater flow does not follow individual property boundaries. For this reason, it is most effective and least costly to develop stormwater restoration practices for "catchments" (land areas that drain to a specific location) serving all the parcels in the catchment. This can be done through a cooperative program, but cannot be accomplished under individual permits.

Second, stormwater flow from some catchments is likely to have greater adverse impacts on Long Creek than flow from other catchments, so that restoration of certain catchments may provide greater restoration opportunities. A restoration plan creates the opportunity to implement the most environmentally effective and cost-effective measures in catchments thought to provide the best opportunities. It also provides the opportunity to implement the most cost-effective measures within catchments first, to learn which measures work best , and to then assess whether more expensive actions are needed.

Third, a coordinated program can fund stream-bank and in-stream restoration projects that are critical to restoring the stream, and may prove among the most cost-effective actions possible in Long Creek. These types of projects usually require extensive coordination across multiple parcels and are difficult or impossible to accomplish through individual permit requirements.

Fourth, as in medicine, prevention is more cost-effective than a cure. A coordinated program can: 1) provide a coordinated pavement sweeping and storm drain maintenance program that will be more effective and less costly than having each landowner contract for their own maintenance; 2) provide education about more environmentally benign (and less costly) landscaping that will reduce pollutants; and 3) promote changes in municipal land use regulations that minimize the creation of stormwater runoff.

Fifth, having a community-supported restoration plan will greatly enhance the ability to obtain grants to help pay for the overall effort, and reduce costs to municipalities and property owners over time.

7.3. Creating a blueprint to implement a coordinated Restoration Program

As we discuss above, the completion of the Long Creek Restoration Plan creates a significant opportunity to ask regulatory agencies to give watershed landowners the option of meeting regulatory requirements by participating in a coordinated Restoration Program. Regulatory agencies will accept the participation in a coordinated program as a viable alternative to an individual permit, however, only if the plan has a specific blueprint for implementation of the coordinated program in a reasonable time frame.

To meet the need for such a blueprint, the Long Creek Restoration Project sets out the recommendation, below, for implementing a coordinated Restoration Program. These recommendations include: 1) a funding mechanism to begin restoration work in a reasonable time period; 2) an organizational structure to administer the funding mechanism and perform the day-to-day work of a coordinated program; and 3) a transition mechanism to set the program in place so that it can be a viable alternative for landowners facing new regulatory requirements.

7.4. Funding implementation of a coordinated Restoration Program

Sometime in the next year, designated watershed landowners will be required to decide how they will meet new regulatory requirements. As we discuss above, these new requirements are independent of the Long Creek Restoration planning process. The Long Creek Restoration Project proposes, however, that landowners be given the option of meeting new regulatory requirements by participating in a coordinated Restoration Program rather than meeting conditions necessary to obtain an individual permit. The Long Creek Restoration Project anticipates that most landowners will voluntarily choose to participate in the Restoration Program, as the costs are likely to be lower than the cost of obtaining an individual permit. The Long Creek Restoration Project anticipates that the coordinated Restoration Program can be funded primarily by public and private landowners in the watershed that choose to participate as a way of meeting their permit obligations.

The Long Creek Restoration Project anticipates that municipalities will choose to participate in the Restoration Program as a cost-effective way to meet their permit obligations in the watershed.

It is important to emphasize that regardless of whether landowners choose to participate in the coordinated Restoration Program or to receive an individual permit, they will be contributing to the restoration of Long Creek.

The Long Creek Restoration Project proposes that "program start up" funds be devoted in part to seeking private and public grant dollars to help fund implementation of the coordinated Restoration Program to the maximum extent possible. (See below).

7.4.1 What will fees for participation in the coordinated Restoration Program cover?

The fee for participation in the coordinated Restoration Program will cover these activities:

- Obtaining and administering grants for watershed projects
- Riparian stream and streambank restoration projects: Revegetating stream banks and fixing the stream channel along important stretches
- Constructing and maintaining structural retrofit projects on the priority list
- Implementing a coordinated monitoring program, and periodic re-evaluation of priorities
- Running incentive programs and providing education to landowners seeking to reduce their impact on water quality
- Providing a coordinated maintenance and "good housekeeping" program (street sweeping, pollution prevention, drain maintenance, reporting to meet permit requirements), taking advantage of economies of scale

The total cost of implementing the coordinated Restoration Program will be determined based on the cost of providing these services. Priority riparian projects and structural retrofits will be constructed based on cost-effectiveness. Priority lists of these projects will be reviewed periodically in light of information from the monitoring and evaluation program and to allow for consideration of additional opportunities identified in cooperation with landowners, including opportunities associated with redevelopment, grant opportunities and new technologies.

7.4.2 Basis for fees for landowners that choose to opt in

If a private landowner chooses to participate in the coordinated Restoration Program rather than obtaining an individual permit, the landowner's fee would be based on the area of impervious cover on the property. Landowners would receive credit for effective treatment systems in place at the time the landowner opts into the Restoration Program, or for treatment systems the landowner installs after the landowner has opted in. This would provide an incentive for landowners to take cost-effective actions to address stormwater runoff on their property.

Public sector entities, including municipalities, MaineDOT and the Maine Turnpike Authority, are also expected to require permit coverage under a stormwater discharge designation for the Long Creek watershed, and may also choose to participate in the implementation of this plan. The contribution of each would be determined based on the area of impervious cover owned. (For a municipality, this would include town roadways, maintenance facilities, municipal buildings and associated parking areas.) If they choose to meet their permit requirements by participating in the Restoration Program, Maine DOT and the Maine Turnpike Authority would implement retrofit opportunities they have identified to address the priority stormwater source areas for which they are responsible, or would contribute in a manner equivalent to private landowners, based on their areas of impervious cover. To the extent public sector entities have road construction and maintenance resources and engineering and technical expertise, they would be allowed to contribute an equivalent level of services and/or expertise toward implementation of the plan in lieu of cash contributions.

Both public and private landowners would receive credit if they undertake maintenance, good-housekeeping, inspection and reporting that would otherwise be performed by the Restoration Program. This would be especially important to municipalities and other entities that have their own maintenance, inspection, and reporting systems in place, but is an option that would be available to all program participants.

7.4.3 Estimated Fees

It is not possible to determine the exact fee that landowners would pay if they choose to participate in the coordinated Restoration Program before the completion of the "program start up" period. A primary task of "program start-up" will be to meet with landowners to determine whether they are interested in participating in the Restoration Program, and to determine which participating landowners will receive credits (See 7.4.4., p. 70). This start up work will be required to determine fees for participating in the Restoration Program. This start up work will precede the date when private landowners are asked to make a decision on whether to meet their permit obligations by participating in the coordinated Restoration Program, or by obtaining an individual permit.

At this time, based on the assumptions set out below, it is estimated that the annual fee for participation in the Restoration Program will be between $2,500 and $3,000 per acre of impervious area for a landowner who 1) receives no credit for on-site stormwater treatment; and 2) wishes to have the Restoration Program perform required maintenance, pavement sweeping, inspection and reporting on the landowner's behalf. Under the credit system proposed below, a landowner could receive an estimated 30% reduction in this fee if the landowner wishes to do maintenance, pavement sweeping, inspections and reporting that the Program would otherwise perform. The landowner could also receive up to another estimated 40% credit for on-site stormwater treatment. (See Section 7.4.4., p. 70).

This estimate of the annual fee is based on the following assumptions:

- $4.5 million in riparian and structural restoration projects will be necessary
- 75% of these projects will be funded through the Plan; others will be accomplished through redevelopment
- Maintenance costs are approximately 5% of construction costs for BMPs, applied only to newly constructed BMPs
- Good housekeeping costs will be $800 per acre through economy of scale, and will be performed by the Plan on private lands only
- Transportation agencies and municipalities will perform their own maintenance, good housekeeping, inspection and reporting and receive credit for these activities
- Monitoring will cost $50,000 per year
- Credits for on-site treatment will be uncommon (20% of impervious acres), and for most of these acres will be relatively modest (20% of possible credit)
- Municipalities will pay reduced rates to cover their contribution to start-up costs

Total estimated cost for Plan implementation will be approximately $14 million including implementation of all structural and nonstructural recommendations as well as the administration of the general permit including billing, legal, tracking and reporting (this is based on all the assumptions listed above).

Table 7a. *Estimated costs of meeting individual permit requirements.*

Range of Costs per acre of IC		
Capital Costs	$30,000	$50,000
Annual Payments on a 10 Year Loan at 5%	$ 3,885	$ 6,475
Annual Maintenance		
Street Sweeping	$ 1,000	$ 1,500
Other Inspection, Maintenance and Reporting	$ 1,000	$ 2,500
Total Annual Costs*	$ 5,885	$10,475

*These estimated costs do not include monitoring costs, which will be required for individual permits.

Providing "credits" for existing BMPs is initially likely to result in only a slight increase in annual fees to landowners who do not receive credits. Remaining questions concerning the level of the fee cannot be answered without knowing who will choose to participate.

7.4.3.1 Comparison to Estimated Cost in Individual Permits

For most landowners, participation in the coordinated Restoration Program is likely to cost significantly less than the cost of work needed to get an individual permit. The cost of implementing treatment equivalent to Chapter 500 requirements is estimated to average in the range of $30,000 to $50,000 per acre of existing impervious area, with additional costs to meet good housekeeping, maintenance, inspection, and reporting requirements (Table 7a). These are typical costs, and actual costs for individual parcels may be either higher or lower.

(Please note that individual permit costs are estimates only, and would vary by property. Landowners will be urged to do their own analysis of the cost of complying with individual permit requirements.)

7.4.4. Proposed Credit System

7.4.4.1. Credit for on-site treatment

The Long Creek Restoration Project concluded that it was important to take into account prior investments in stormwater management and stream protection by landowners in designing the funding mechanism for the Restoration Program. The Project also concluded that it was important to create incentives for landowners who elect to participate in the Restoration Program to take cost-effective stormwater management actions on their own.

The mechanism selected is a "credit" system that would reduce fees a landowner pays to support the Restoration Program. "Credits" would result in a reduction in – but not elimination of – the fees charged to land owners with installed treatments. Credit would not be all or nothing, but reflect different levels of effectiveness of on-site stormwater treatment. Credits would reduce fees charged on the area of impervious surfaces treated.

Even the best stormwater treatment does not eliminate 100% of the impact of urban runoff. Therefore, while the credit system provides for potential significant reductions in the fee, the only way envisioned to eliminate all fees is to remove the impervious area. Accordingly, credit for on-site treatment would apply only to the portion of the fee that will fund physical construction of stormwater treatment and riparian restoration projects ("retrofit portion", which is estimated to be 40% of the total fee. Even sites that get full credit for on-site treatment will continue to contribute to other watershed restoration costs, like monitoring, maintenance, education and planning. (Note: It is likely that the percent of total fee allocated to the retrofit portion will be higher than 40% of the total, which would in turn raise the percentage available for credit for on-site treatment. The percent of total fee allocated to the retrofit portion will be carefully evaluated during the "program start up" period discussed in Section 7.6.)

In developing the credit system, the planning committees focused on three goals:

1. Fairness -- It is important to recognize past investments in stormwater management.
2. Effectiveness – Credit should be provided for structures that benefit the stream, and not for those that do not.
3. Incentives – The incentives created by the credit system should encourage landowners to take cost-effective steps to reduce stormwater impacts to downstream waters.

Stormwater treatment technology has evolved significantly over the last several decades. Regulatory requirements have also changed, as the technical focus for stormwater management shifted from an emphasis on reducing flooding and preventing damage to infrastructure, towards controlling pollutants and,

Table 7b. *Credits for existing structures providing on-site treatment.*

Standard For Which Existing Structures were designed	Credit available to apply to **retrofit portion** of fee	Equivalent reduction in the total fee based estimate that retrofit portion is 40% of total fee
2-10-25 Retention Standard	10%	4%
Sliding Scale Standard	10%	4%
Both the 2-10-25 Standard and the Sliding Scale Standard,.	20%	8%
Chapter 500 standards	100%	40%

most recently, towards protecting the health of rivers and streams. It is unfortunate but true that many older stormwater management structures – designed to provide other benefits – provide little or no benefit to the water quality of Long Creek.

What this means is that the "Fairness" and "Effectiveness" goals described above are often in conflict. A compromise was necessary. The Project realized that we would have to treat existing structures; new construction; and modifications of existing structures or installation of new structures (called "retrofits") differently, as follows:

Existing Structures

Credits for existing structures will be based on the regulatory criteria the structures were designed to meet, subject only to continued effectiveness. Maine has had three different sets of requirements for stormwater treatment, called the "2-10-25 retention standard", the "Sliding Scale Standard" and the present-day "Chapter 500" standards (Table 7b).

New Construction (Development or re-development)

New construction in the Long Creek watershed is required to meet the present-day Chapter 500 standards under State and local rules. Where that standard is met, credit will apply as indicated above. Innovative efforts to go beyond Chapter 500 minimums may receive grants or special recognition as well.

Retrofits

Credits for retrofits are the most complicated component of the system to implement, because each retrofit is unique, and thus requires site-by-site evaluation. Benefits of retrofits to Long Creek can be roughly divided into three categories:

1. Reductions in the impact of altered hydrology due to impervious cover on stream flow, the stream channel and aquatic habitat;
2. Reductions in pollutants entering Long Creek; and
3. Reductions in the thermal impact of urban runoff on the stream.

Retrofits that effectively provide a level of treatment similar to what would be achieved through application of Chapter 500 standards would receive up to 40% credit of the total fee. Other projects could receive anywhere from 0% to 40% credit, depending on which benefits, and the extent of benefits each projects would provide to Long Creek. (Percentages in this section are based on an estimate that 40% of the total fee will be allocated to the "retrofit portion" of the fee. It is likely that the percent of total fee allocated to the retrofit portion will be higher than 40% of the total, which would in turn raise the percentage available for credit for on-site treatment. The percent of total fee allocated to the retrofit portion will be carefully evaluated during the "program start up" period discussed in Section 7.5.)

Up to 16% credit against the total fee would be available for projects that control runoff volume and timing, and thus help provide stream channel protection. A 10% credit would be applied to projects that provide "24-48 hour extended detention of the first 1 of runoff or storage and infiltration that has the equivalent effect on the rate of discharge." Partial credit would be available for projects with lesser water storage or infiltration capacity.

Up to an additional 16% credit against the total fee would be available to retrofits that provide significant pollutant removal. Pollutants of interest include nutrients, toxic chemicals, road salts, and bacteria, among others.

Up to an additional 8% credit against the total fee would be available for projects that provide some temperature protection to Long Creek. Runoff from parking lots in mid-summer is often much warmer than is healthy for fish and other aquatic organisms. Conversely, in the colder months or at night, urban runoff may be colder than the water in the stream. The increased temperature variation stresses many stream inhabitants, contributing to overall loss of stream health. A variety of techniques from the simple (shading) to the complex (underground thermal reservoirs) can reduce these impacts.

7.4.4.2. Credit for performance of maintenance, pavement sweeping, inspection and reporting

Under the proposed credit system, a landowner could receive full credit against the portion of the fee allocated to maintenance, pavement sweeping, inspection and reporting if the landowner undertakes these tasks. This could provide a 30% reduction in the total fee, as the fee is currently estimated.

7.5 Administrative structure for implementation of the Restoration Program

7.5.1 Administrative structure considerations

The Long Creek Restoration Project determined that it wished to create administrative mechanisms that could accomplish the following:

- Coordinate across municipal boundaries and with multiple municipalities
- Contract with and provide services to both public and private property owners
- Encourage public-private partnerships and participation
- Apply for and administer grants
- Serve as an agent for a discharge permit
- Be eligible for low interest State Revolving Fund loans
- Operate with the direction of a governing committee that includes public and private representatives
- Provide a structure that is adaptable or expandable to other impaired watersheds
- Be in place in time to provide property owners with an alternative to obtaining individual discharge permits

7.5.2 Recommended administrative structure

After reviewing a range of possible administrative models, the Long Creek Restoration Project recommends an interlocal agreement between participating municipalities, which would contract with the Cumberland County Soil and Water Conservation District (CCSWCD) to administer the implementation of the coordinated Restoration Program under the direction of a governing board made up of representatives of municipalities, private landowners, concerned non-profits and state agencies.

The Long Creek Restoration Project recognizes a number of advantages to this approach. Primarily, relying on an existing regional entity to administer the program will be less costly and more efficient. It has been determined that the CCSWCD is well suited to implement this coordinated Restoration Program.

CCSWCD is an entity of the State established to promote stewardship and conservation of soil and water resources in the Cumberland County area. Under its enabling legislation, it has the authority to serve as an agent for a discharge permit; to secure low interest State Revolving Fund loans; and partner with municipalities, state agencies, private landowners, and non-profits. CCSWCD has extensive experience coordinating across municipal boundaries and with multiple municipalities and MEDEP on water quality issues; applying for and administering grants; and experience providing education and technical services to public and private entities.

CCSWCD also has experience working with independent steering committees responsible for overseeing designated programs, and has the demonstrated capacity to work with a governing board that includes public and private representatives.

CCSWCD has expertise in watershed and stormwater issues. It currently provides education and technical assistance to landowners and municipalities in the area of stormwater treatment. CCSWCD has also worked extensively with the four municipalities concerning stormwater management issues in the context of the Interlocal Stormwater Group.

At the request of the Project, the CCSWCD has reviewed the request to fulfill this role, and is willing to administer the implementation of the coordinated Restoration Program under the direction of a governing board made up of representatives of municipalities, private landowners, concerned non-profits and state agencies.

7.5.3 Interlocal agreement and governing board

CCSWCD will work with the four watershed municipalities to draft an interlocal agreement to establish a quasi-municipal entity, hereafter referred to as the Long Creek Watershed Management District (LCWMD). The organization of the LCWMD under the Maine interlocal agreement statute would permit creation of a governmental entity that would be overseen by a governing board. The interlocal agreement statute would limit the personal liability of governing board members under the Maine Tort Claims Act so that they would have the same protections as any other Maine public officials, which will be important to obtaining participation of governing board members. In order to ensure adequate representation of public and private landowners, the interlocal agreement will set out the composition of the governing board, which will require that specific numbers of private landowners be appointed. Appointments to the governing board will be by the City or Town Councils.

It will be critical to develop a stakeholder governing board that is sufficiently diverse to provide technical expertise and represent the perspectives of the municipalities, private landowners and concerned non-profits. It will also be important that the governing board be a manageable size. The governing board will be constituted by the end of the program start up period. The Models and Outreach Committee of the Long Creek Restoration Project will provide guidance to CCSWCD until the governing board is established.

The exact composition of the governing board will be determined by the end of the program start up period. One possible configuration that has been discussed would include the following list of board members:

- 4 Municipal representatives
- MaineDOT/ MTA representatives
- CBEP representative
- Business representatives
- 2 Residential/public members
- Land Trust representative
- Person with engineering expertise (either from additional member or member meeting other criterion)
- Person with water quality or stream ecology expertise (either from additional member or member

meeting other criterion)

The watershed municipalities, working in cooperation with CCSWCD and the Models and Outreach Committee, will determine if the governing board should include additional representatives.

Individual landowners would agree to participate in the Long Creek Watershed Management Plan by entering into agreements with the new District. When landowners constituting a specific percentage (set by the new District governing body) of impervious surface have signed agreements, the new District then would become effective, entering into construction, maintenance and monitoring contracts and beginning the implementation of the management plan for the five-year permit. If MaineDOT and MTA choose to participate in the Restoration Program, they could be part of the interlocal agreement with the municipalities or opt to be members like the private landowners.

The Long Creek Watershed Management District would contract with CCSWCD to administer the implementation of the coordinated Restoration Program under the direction of a governing board made up of representatives of municipalities, private landowners, concerned non-profits and state agencies. Restoration Program implementation will be performed by CCSWCD staff or entities with which CCSWCD contracts to perform Restoration Program work.

7.6 "Program Start Up" period

The CCSWCD will complete the following tasks during the program start up period:

- Seeking grant and stimulus funds
- Setting up the program structure for plan implementation including municipal interlocal agreement, landowner contracts, and construction and maintenance easements
- Developing the monitoring and evaluation program
- Initiating outreach to landowners to explain the program and the credit system, and seek landowner input
- Assessing properties for good housekeeping and maintenance needs and credit awards
- Setting up and developing cost estimates for coordinated maintenance program
- Verifying acreage that needs to be swept and Best Management Practices that need to be maintained
- Identifying which landowners will participate in the Program
- Setting up a project database and a billing system
- Establishing the governing board
- Finalizing contracts with participating landowners

The program start up period will provide the opportunity to address essential program details such as the cost of participation; how landowners can opt into and out of the program; level and predictability of fees; assurance that contribution through participation will be valued; and how to include provisions to ensure cost effectiveness for landowners who want to redevelop their property and stay in the program. The outreach to landowners will also include gathering input to determine other questions that will need to be addressed in order for landowners to participate.

7.6.1 Funding a "Program Start Up" period

There are two reasons that it is essential to fund a program start up period:

First, program set up will be required to determine fees necessary to implement the coordinated Restoration Program. This work must precede the date when private landowners are asked to make a decision on whether they wish to meet their permit obligations by participating in the Restoration Project, or by obtaining an individual permit.

Second, it will be vital to begin coordinated efforts to obtain Federal stimulus funds and grant dollars as soon as possible. Funds obtained through these sources will make implementation of the Restoration Program less costly to municipalities, private landowners, and state agencies going forward.

The Long Creek Restoration Project requests that the four municipalities fund a program set up period, with any funds paid during this period to be credited against funds that the municipalities would be asked to contribute over the subsequent five years of participation in the coordinated Restoration Program. The Long Creek Restoration Project is also actively seeking grant funds to cover start up costs. Other watershed

Table 7c. *Restoration Program start up cost estimates.*

	Minimum	Maximum
Outreach to and work with landowners to explain Plan and alternatives	$ 21,450	$ 28,600
Set up and first year of monitoring program	$ 40,000	$ 60,000
Grant development and writing	$ 10,400	$ 19,500
Set up Governing Board	$ 3,900	$ 5,200
Develop standard landowner contracts	$ 8,650	$ 13,300
Develop municipal contracts	$ 8,650	$ 13,300
Develop and set up database for tracking of properties, existing BMPs and maintenance needs	$ 30,000	$ 50,000
Inventory all properties and assess credits awarded	$ 38,760	$ 48,450
Set up financial controls	$ 23,500	$ 35,400
Billing database development	$ 5,000	$ 7,500
TOTAL	**$ 185,310**	**$ 273,750**

entities, including MaineDOT, the Maine Turnpike Authority and private landowners, are invited to contribute to cover the costs of the program start up period on the same terms. The Long Creek Restoration Project is also exploring additional sources of short term funding for the program start up period.

The cost of the program start up period is estimated in Table 7c.

8. Projected Implementation Schedule

2009 – 2010: Cumberland County Soil and Water Conservation District (CCSWCD) implements program start up to establish the mechanisms for implementation of the Management Plan.

This includes, but is not limited to:

- Seeking funding to support program start up;
- Working with watershed municipalities to establish the Long Creek Management District (LCMD);
- Completing the landowner contract for Plan participation;
- Developing Long Creek Watershed property database to track Plan implementation, and installation, maintenance and performance of BMPs;
- Assessing watershed properties to provide the basis for the fee structure;
- Developing financial controls;
- Securing landowner commitments for plan implementation; and
- Establishing a water quality monitoring program to assess the progress of plan implementation.

2009 – 2010: CCSWCD and City of South Portland obtain a $2,095,000 loan with principal forgiveness of $579,834 from the Maine State Revolving Fund. This funding was provided by the EPA under the American Recovery and Reinvestment Act of 2009. CCSWCD implements $2,095,000 of Tier 1, Tier 2 and stream retrofit projects.

2009: MDOT obtains $2,000,000 in American Recovery and Reinvestment Act of 2009 funding and implements retrofit of Maine Mall Road.

2010: CCSWCD receives first annual payment from participating landowners. It is anticipated that fees from participating landowners will generate $575,000 - $1,260,000 cash or in-kind equivalent each year for a ten year timeframe.

2010 – 2019: Revenue from participating public and private landowners will support annual Plan implementation including, but not limited to:

- Installation of approximately $500,000 of on-the-ground structural retrofits;
- Implementation of watershed wide maintenance program including a targeted vacuum sweeping program and maintenance of installed best management practices;
- Education of watershed property owners regarding landscaping practices, winter maintenance and pollution prevention practices, and continuance of www.restorelongcreek.org website;
- Collaboration with municipal planners to work towards changes in municipal codes to support LID practices and provide stream protection; and
- Monitoring of water quality and performance of installed measures to determine progress and adjust approach, as appropriate.

A summary listing of anticipated management measures can be found in Table 8a on page 79.

2009 – 2015: MDEP first five year MPDES General Permit for Post-Construction Discharge of Stormwater in the Long Creek Watershed (in response to EPA using Residual Designation Authority under the Clean Water Act to require discharge permits for post-construction stormwater discharges from landowners with one acre or more of impervious surface). Landowners will have 180 days after the general permit is issued to decide whether or not to file for the general permit or seek coverage under an individual permit.

2014: The LCMD in partnership with the CCSWCD, DEP, EPA and Casco Bay Estuary Partnership will review Plan implementation to date, BMP performance information and water quality data to assess progress on Plan implementation. The LCMD will work with DEP and EPA to make necessary adjustments to Plan implementation in order to meet the goal of complying with State water quality standards by 2019.

2009 – 2019: Implementation of Projects
The restoration strategy presented in the plan is an adaptive approach where the measures that are expected to provide the most benefit to the stream will be implemented first and the stream and its biota will be continuously evaluated to gauge the response. The goal is to complete Tier 1 & Tier 2 structural retrofits treating 150 acres of impervious surface and all ten identified in-stream habitat, riparian habitat and floodplain restoration recommendations or equivalent measures in a ten year timeframe.

The timing and selection of projects will depend on which landowners participate in the cooperative implementation of the Plan, impact to the stream as well as construction and maintenance property easements (which on private property still under mortgage require the sign-off of the mortgage holder). In addition, some recommended fixes are located on properties that are less than one acre of impervious surface, which might make securing the easement more difficult.

As previously stated, the timing and selection of projects will depend upon securing easements as well as landowner participation in general permit. An anticipated progression of implementation may be as follows (see Tables 8b and 8c, page 80, for site descriptions):

2009: E-24 – Tier 2; C-11 - Tier 1 & 2; Stream restoration #3 (South Branch (upper); E-02 – Tier 2 (DOT)

2010: A1-05 – Tier 1; Stream restoration #9 (South Branch (lower)); Stream restoration #1 (Goodyear Branch); Stream restoration #6 (Middle Long Creek)

2011- 2019: E-24 – Tier 1; Stream restoration #4 (Lower Long Creek "B"); B-21 – Tier 1 & 2; A1-03 – Tier 2 (DOT); A1-14 – Tier 1 & 2 (DOT); Stream restoration #5 (North Branch (lower); Stream restoration #7 (Lower Long Creek "A"); Stream restoration #10 (North Branch (middle); Stream restoration #2 (Upper Long Creek); E-34 – Tier 1 & 2; A1-05 – Tier 2; C-08 – Tier 1 & 2; Stream restoration #8 (Lower Long Creek "A")

Table 8a. Summary of the Three Categories of Anticipated Management Measures

NONSTRUCTURAL MANAGEMENT MEASURES
Implement Code, Zoning and Design Guidelines Revisions
Consider Exceeding MDEP Chapter 500 stormwater thresholds for new development
Modify and/or clarify redevelopment stormwater management requirements
Modify local code, design standards and guidelines to incorporate LID techniques
Implement transportation demand strategies to decrease the use of single occupant vehicles
Implement parking demand strategies to reduce need for existing and future paved parking facilities
Consider market incentives for enhanced stormwater management
Reference MDOT Waterway and Wildlife Crossing Policy and Design Guide, 3rd Edition (2008) with the municipal design standards for new culverts and stream crossings
The MDEP should consider adjusting Chapter 500 general standards requirements for rooftop runoff in order to promote the separated management and treatment of these impervious surfaces.
Allow green roof installations (meeting basic design criteria) to provide 100% of the required stormwater management for roof areas.
Implement Long-Term Planning Committees/Considerations
Develop a long-term-strategy for public and private snow storage
Continue on-going dialogue with the Maine Turnpike Authority on Turnpike expansion
Coordinate restoration activities with Portland Jetport
Coordinate restoration activities with South Portland Land Trust concerning Stream Corridor Conservation Easements and Greenspace Corridor.
Refine and Complete Long Creek Watershed Stormwater Drainage Map
Pollution Prevention
Develop a targeted watershed street and parking area sweeping program
Winter Salt Alternatives
Appropriate resurfacing sealants
Develop outreach materials for proper handling and management of toxic materials on private property
Develop training program for local landscaping contractors on integrated pest management and shade management
Private facility inspection and maintenance program
Education and Training
Develop stormwater grant program for private management efforts
Develop a Long Creek stewardship program

IN-STREAM, RIPARIAN AND FLOODPLAIN HABITAT MANAGEMENT MEASURES	
Riparian Vegetation Enhancement and Replacement	Invasive Terrestrial Plant Control
No-Mow Zones	Long-term Stream Corridor Management Plan
Wood/Boulder Addition	Increased Baseflow Water Supply
Geomorphic Restoration (Floodplain/Streambank)	Recreation Opportunities
Conservation Easement	Clearing Wood and Debris Out of Culverts
Culvert Replacement or Modification	National Trash Clean-Up Week

STRUCTURAL RETROFIT MANAGEMENT MEASURES	
Soil Filter Media	Below Grade Storage with Filter
Infiltration Gallery	Esplanade Filter Box
Wet Pond	Pervious Pavement Alteration
Gravel Wetland	Dry Detention
Roof Drip-Edge Filter	Diversion to Buffer
Below Grade Treatment Train	Outlet Stabilization and Outlet Sediment Control

Table 8b. Structural Retrofits – Nine Priority Catchments

DEP Catchment #	Descriptive location	Tier 1 Cost Estimates*	Tier 2 Cost Estimates*	Impervious Area (Acres)	Tier 1 & 2 Impervious Acres Treated	Tier 1,2 & 3 Impervious Acres Treated
E-34	Hannaford	$85,000	$88,000	10	8.4	10
E-24	Maine Mall - Philbrook Avenue	$745,000	$555,500	59.9	74**	74**
A1-03	Maine Mall Road - Guitar World to Mallside Plaza	^	$112,000	14.4	8	11.9
A1-14	Maine Mall Road – Darling Ave to Guitar World	$46,500	$116,000	5.7	2.5	3.5
A1-05	Mallside Plaza and adjacent properties	$460,000	$165,000	13.7	10	12
C-11	Darling Avenue	$222,000	TBD	11.3	4.6	11.3
E-02	Maine Mall Road – Toy's R Us to just beyond Maine Mall	^	$165,000	14.4	12.2	14.4
B-21	Colonel Westbrook Industrial Park	$175,000	$94,000	15.5	15.3	15.5
C-08	Fairchild and National Semiconductor	$130,000	$35,000	30.5	14.8	30.5
^ Tier 1 addressed through redevelopment				**Total acres treated:**	**149.8**	**183.1**

**E-24 management measures treat impervious acreage outside of the catchment.

Table 8c. In-stream Habitat, Riparian Habitat and Floodplain Restoration Recommendations

Project Name	Additional Project Details	Total Estimated (ft) Restoration Length	Total Cost Estimate
1. Goodyear Branch	Colonel Westbrook Executive Park – install riparian buffer and in-stream habitat	2245	$152,619
2. Upper Long Creek	Main Stem above confluence with Goodyear Branch (Sable Oaks up to Spring Street) – install riparian buffer	2640	$63,013
3. South Branch (upper)	South branch - channelized section paralleling Philbrook Avenue – install riparian buffer	2180	$105,419
4. Lower Long Creek "B"	Main stem from Guitar World down to Cornerbrook – remove catch basins & floodplain fill	1415	$232,500
5. North Branch (lower)	North Branch from Foden Road down to confluence with Main Stem - restore instream habitat through the placement of wood and boulders in the stream.	1030	$19,500
6. Middle Long Creek	Main stem from confluence with Goodyear Branch to Turnpike – chop & drop to create habitat	4470	$19,500
7. Lower Long Creek "C"	Main stem from Maine Mall Road to Guitar World - Stabilize eroding bank using wood placement and vegetation establishment. Place wood and boulders to restore in-stream habitat.	1105	$41,815
8. Lower Long Creek "A"	Main stem from Foden Road to Clark's Pond - Remove fill from floodplain to reduce channel erosion. Stabilize eroding bank using wood placement and vegetation establishment. Place wood and boulders to restore in-stream habitat.	2970	$250,500
9. South Branch (lower)	South branch within Clark's Pond retail area – address fish passage issues at two culverts & remove invasive plants that are infringing on floodplain	3220	$339,500
10. North Branch (middle)	North Branch upstream of Foden Road - clean out debris blocking fish passage at culvert; assess need for further restoration at site.	740	$24,500

*The total cost to implement the Plan will be approximately $14 million. This includes implementation of all structural and nonstructural recommendations mentioned above as well as the administration of the general permit including billing, legal, tracking and reporting (see page 70 for assumptions regarding this estimate).