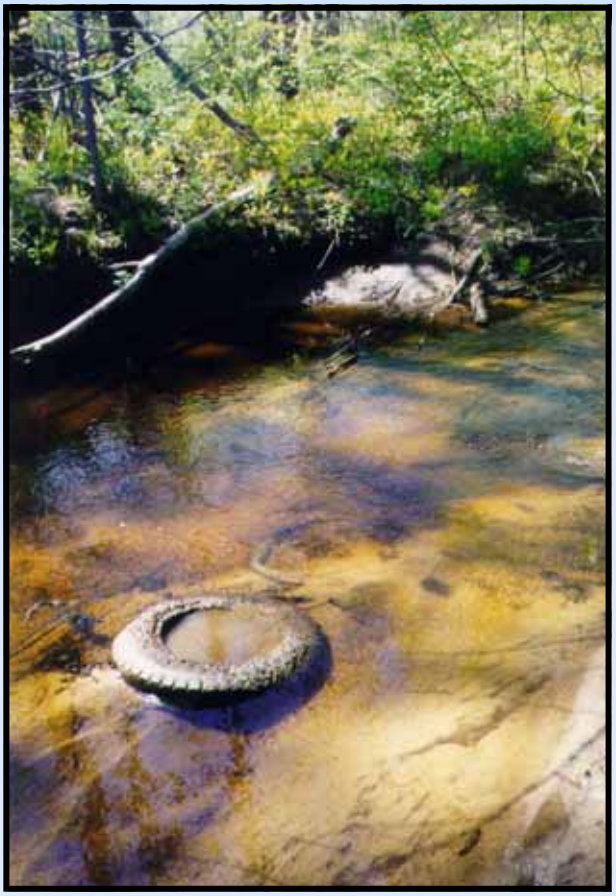
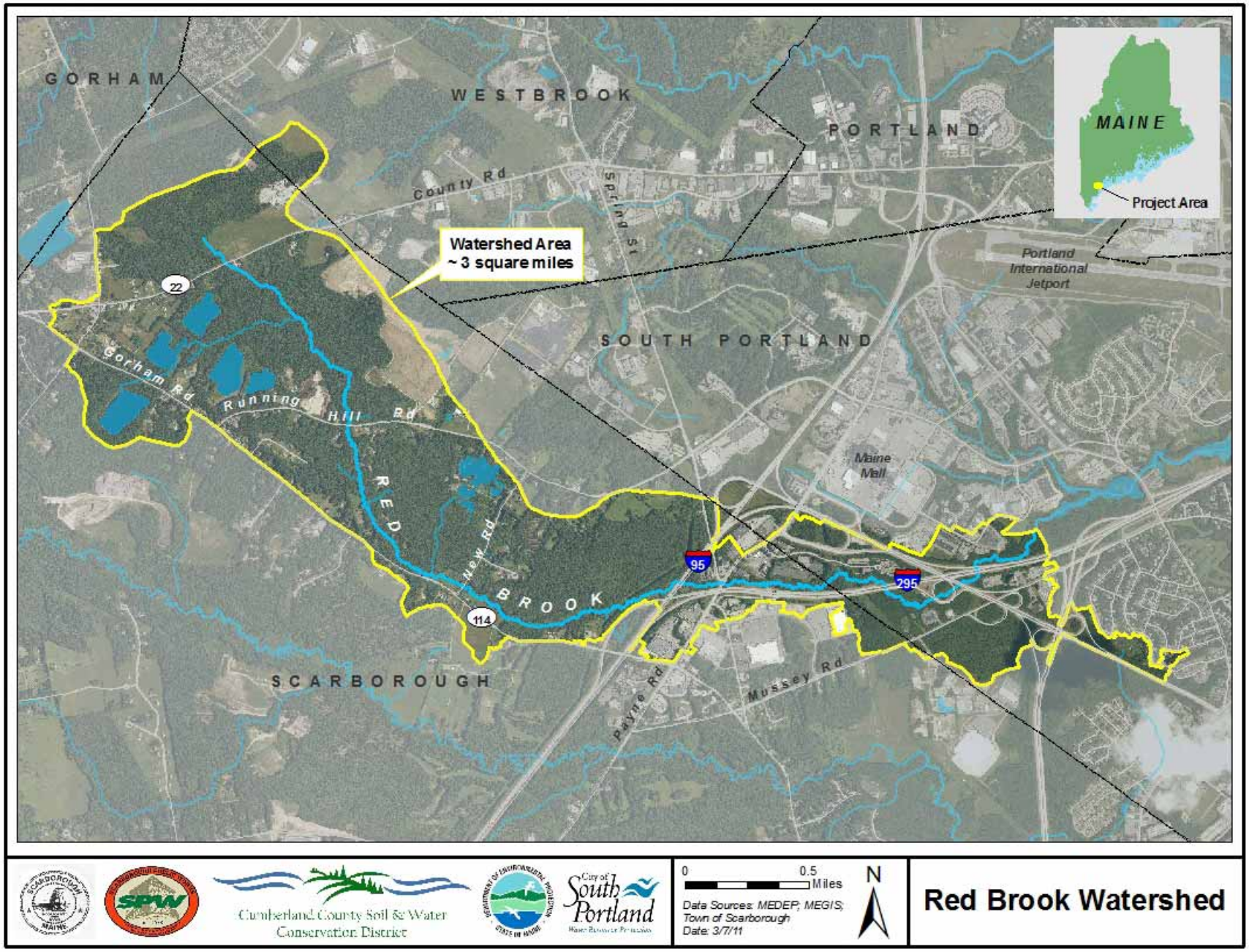
Red Brook Watershed Based Management Plan



June 2011

Cumberland County Soil & Water Conservation District
for the
Town of Scarborough


GORHAM
WESTBROOK
PORTLAND
SOUTH PORTLAND
SCARBOROUGH
MAINE
Project Area
Watershed Area
~ 3 square miles
County Rd
Spring St
Portland International Jetport
Gorham Rd
Running Hill Rd
Main Rd
RED BROOK
Maine Mall
Payne Rd
Mussey Rd
22
95
295
114
Cumberland County Soil & Water Conservation District
City of South Portland
0
0.5
Miles
Data Sources: MEDEP; MEGIS; Town of Scarborough
Date: 3/7/11
N
Red Brook Watershed

Draft Red Brook Watershed Management Plan

www.cumberlandswcd.org/redbrook/index.htm

Prepared by Cumberland County SWCD
in cooperation with the
Town of Scarborough and the
Maine Department of Environmental Protection

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1. Introduction

Why is this plan needed?

The Town of Scarborough recognizes that growth management is important for protecting Red Brook. This watershed management plan looks at the unique conditions of the Brook to develop specific actions and approaches to minimize impacts to the Brook. Red Brook is listed in Maine's 2010 303(d) list and Chapter 502 as an urban impaired stream. This management plan describes the impairments and identifies the recommendations needed to restore habitat by establishing long term goals and priorities to attainment of Maine water quality standards.

The Town of Scarborough also pursued the Red Brook Watershed Management Plan to address two areas in the Maine Stormwater Law (38 M.R.S.A. §420-D.11.). First, under Chapter 500 in the Stormwater Law, a compensation fee is required for development projects located in the Red Brook and other urban impaired stream watersheds. Fees range from $1,000 - $5,000 per acre of impervious surface, depending on the type of surface. The Town has opted to pursue the development and implementation of this Watershed Plan as alternative to this fee system. Once a Watershed Plan is approved by DEP, Scarborough could request that the compensation fees to developers are waived or reduced.

The Stormwater Law also includes a provision that allow a municipality to substitute its own stormwater management program for DEP stormwater permit requirements. Municipal programs that qualify for this delegation of authority must treat stormwater from new and existing sources in the watershed in a way that is as good, or better, than would be achieved by stormwater permits issued by the DEP. The Town may be interested in pursuing this local approach since implementation of the Red Brook Plan will address new and existing stormwater issues.

How was the plan developed?

The plan was developed using a collaborative approach. This approach aimed to actively involve local stakeholders in selecting management strategies that may be implemented over time to solve problems in the watershed. A public meeting was held on May 18, 2010, and two subcommittees met a total of four times over the following eight months to develop and refine management strategies. The Red Brook Watershed Based Management Plan characterizes existing conditions, identifies and prioritizes problems, defines objectives for management, and recommends protection and remediation strategies and actions. The Plan was developed to meet EPA Guidelines using the nine components that are required in watershed based management plans to restore impaired waters (Appendix B). This is intended to enable project partners to seek future EPA and DEP funding to help implement the plan.

Who was involved?

The Town of Scarborough and the Cumberland County Soil & Water Conservation District partnered to lead and implement the planning project. The City of South Portland, Maine Department of Transportation, Maine Turnpike Authority, Maine Department of Environmental Protection, watershed residents and others were all active participants in the process.

Who should read this plan?

Any group that influences or is affected by water quality, habitat management, and land use decision makers should read this report. Municipalities and local groups in and around the Red Brook Watershed should use this plan as foundation for local action, stream restoration projects and for altering ordinances. State and federal agencies can use this plan to enhance their understanding of local watershed conditions and as a basis for coordinating planning, permitting and regulatory decisions.

2. Executive Summary

2.1 Red Brook and its Watershed

Red Brook is located in the Town of Scarborough and the City of South Portland, on the southern coast of the State of Maine in the southeastern corner of the County of Cumberland, the State's most populous county. It is a fresh water stream approximately 7.15 miles long and is a tributary to Clark's Pond, which flows to the Fore River and Casco Bay. Red Brook generally has a low gradient , and in most locations has streambeds dominated by fine sediments (i.e., sands, silts and clays).

The Red Brook watershed encompasses 3.2 square miles in Scarborough, South Portland and a small section of Westbrook. The watershed is a complex mix of land uses that includes residential, industrial, retail and forest land. The watershed includes a one mile section of the Maine Turnpike, I-295, other local and state roads and a regional waste incinerator and associated landfill. Parts of Red Brook were relocated to facilitate the construction of I-295 in the early 1960s.

Figure 1. Red Brook Watershed

2.2 Water Quality Problems

Red Brook has a statutory state water quality classification designation of Class C. According to the integrated Water Quality Monitoring and Assessment Report (DEP,2010) Red Brook does not meet Class C designated uses and criteria. Specifically, it is listed as impaired because is does not meet the designated use for fishing due to PCB contamination and it does not provide for aquatic life due to stream habitat conditions.

In terms of habitat the upper sections of the watershed for the most part remain stable due to limited development beside the stream. The lower sections are unstable and showing signs of stress due to the alterations to the stream channel and floodplain from development and construction of highway crossings over the stream.

In addition to habitat problems, Red Brook is listed as impaired due to PCB contamination from unknown sources. Although there is no evidence that it was a source to the stream, PCBs were documented in one location near Red Brook just above Running Hill Road. Recently, new owners have worked with the Maine DEP's Voluntary Response Action Program

(VRAP) to clean up the property prior to redevelopment. Soil samples from around the property were found to have elevated PCBs and in 2009 the contaminated material was encapsulated (sealed) in concrete.

303(d) List
identifies water quality limited waters within the state and the causes and sources of non-attainment.

If the encapsulated PCBs were indeed the only source to Red Brook, then it would follow that PCB levels may now eventually decrease in fish tissue over time. Since PCBs are so long-lived in the environment, this could take several years to happen. The main course of action in terms of PCB's is to continue monitoring PCB levels in fish tissue and wait for this to decline. This plan recommends the continuation of monitoring PCB's on a five year rotational basis through fish tissue analysis. However, the main focus of this plan is on the restoration of stream habitat and protection of further degradation.

Table 1. Excerpt from 2010 DEP 303(d) List

SEGMENT NAME	CAUSE	SEGMENT SIZE	SEGMENT CLASS
Red Brook	Habitat Assessments	7.15	Class C
Red Brook	Polychlorinated biphenyls	7.15	Class C

2.3 Plan Development and Community Outreach

Restoration is necessary because Red Brook does not meet state water quality classification standards. The health of Red Brook is also important to the health of Clark's Pond, the Fore River and ultimately, the Casco Bay Estuary. The goal of the Red Brook Watershed-Based Management Plan project is to develop a locally supported watershed based plan that outlines strategies to help restore the water quality of Red Brook. Given existing conditions of the Red Brook Watershed, the Town's continued goal is to enhance the quality of life, minimize impacts to the environment and manage the build-out of identified growth areas in a more comprehensive and responsible way.


Red Brook Public Meeting on May 18, 2010

The Town of Scarborough has been working with the Cumberland County Soil & Water Conservation District to develop a watershed-based management plan, which is intended to serve as a blueprint for restoring and protecting Red Brook. Incorporating input from stakeholders, this plan identifies the most pressing problems in Red Brook and establishes goals, objectives, and actions for resolving them. The management plan also contains strategies for monitoring progress and financing implementation.

Adaptive Management Approach

Adaptive management is the process by which new information about the health of the watershed is incorporated in the watershed management plan. An adaptive management

approach is widely recommended for restoring urban watersheds (CWP, NSF paper). The adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short-time frame. As new data/information and or technology become available, this approach establishes a mechanism for restoration efforts that can be adjusted to meet the current needs of the watershed over time.

2.4 Red Brook Action Plan

The Red Brook action plan draws from recommended strategies and further developed by watershed stakeholders at two public meetings and four subcommittee meetings. A Red Brook Workgroup will be established to work on implementing several actions under each of the three goals and six objectives. Additional details can be found outlined in Table 10 and described in the following sections.

Red Brook in the fall.

Goal #1 - Improve the water quality of Red Brook to meet Maine water quality standards.

⇒ Ensure that Red Brook meets Class C water quality standards for in-stream habitat.
⇒ Continue to monitor PCB levels in fish tissue until below action levels.

Goal #2 - Protect water quality and aquatic and wildlife habitat from degradation so the brook continues to meet State water quality standards.

⇒ Develop zoning and ordinances to guide new development in a manner that protectsthe brook.
⇒ Improve the management of stormwater runoff for existing development in an effort to improve stormwater quality and reduce peak stormwater flow.
⇒ Develop an efficient comprehensive approach in the development review process to minimize impacts to Red Brook.

Goal #3 - Build community support for the protection and enhancement of the land and water resources of the Red Brook Watershed.

⇒ Develop an outreach program for citizens and businesses to promote and implement the watershed management plan.
⇒ Develop and establish the Red Brook Workgroup to oversee Plan implementation and work towards long term health and ensure the Watershed Based Plan goals are achieved.

Phased implementation is expected to occur for many of the restoration projects identified in the plan. Many will be implemented by the Town of Scarborough, MDOT and MTA through ongoing Operations and Maintenance programs or Capital Improvement projects. The proposed ordinances relating to development will be pursued by the Town Planning Department. Outside funding, primarily in the form of grants, will be needed to support this work, funding some of the in-stream restoration projects, limited stormwater retrofits and stream crossing projects.

Self-supporting funding is not currently envisioned for the Red Brook Watershed although options including a stormwater utility as a funding mechanism could be explored. If milestones and goals are not met as anticipated, through the implementation of the smaller in-stream restoration projects, stabilization of stream corridor erosion sites, alternative funding sources will be explored due to the significantly higher levels of costs to implement large structural retrofits and stream crossing work.

3. Watershed Description

3.1 Location

Red Brook is a small, freshwater stream located in the Town of Scarborough and City of South Portland, on the southern coast of the State of Maine. The headwaters of Red Brook are located north of Route 22 at the Smiling Hill Farm and flows in a southeast direction approximately 7.15 miles. Red Brook generally has a low gradient and, in most locations, has streambeds dominated by fine sediments (i.e., sands, silts and clays).

Red Brook's 3.2 square mile watershed is located primarily in the Town of Scarborough and City of South Portland, although a small portion of the watershed extends into the Town of Westbrook (Figure 1). The watershed is a mix of land uses that includes sparse residential, limited industrial, retail and significant forested land. The watershed includes a one mile section of the Maine Turnpike along with a regional waste incinerator and associated landfill.

3.2 Population and Demographics

Scarborough is a community of approximately 19,000 residents. Scarborough has a large land area, with 54 square miles of land that ranges from suburban to rural in character. Scarborough is one of the fastest growing communities in Southern Maine and has a population density of approximately 807 people per square mile. Its four public sand beaches (Ferry Beach, Pine Point Beach, Scarborough Beach and Higgins Beach) are popular recreation destinations. In addition to its residential growth, Scarborough has also been consistently growing commercially due to its location along the Maine Turnpike and I-295 and its close proximity to Portland and South Portland. Much of this commercial growth has occurred in the eastern reaches of the Red Brook watershed in the vicinity of Payne Rd and the Maine Mall.

South Portland is a community of approximately 23,000 residents that covers 14.3 square miles. The land is considered primarily suburban, but it also includes a working waterfront, a

major shipping port for oil, the largest railroad yard in New England, the Maine Mall, Fairchild and National Semiconductor manufacturing plants and the main runway of the Portland Jetport. South Portland has many public parks within its boundaries including Mill Creek Park, Wainwright Farm and Hickley Park, a 3-mile paved Greenbelt walkway, Willard Beach and several recreational marinas. South Portland's population density is approximately 1,944 people per square mile, and the population is relatively stable.

3.3 Climate

Scarborough and South Portland have an average low temperature of 10 degrees Fahrenheit in the winter to an average high of 77 degrees Fahrenheit in the summer months. The annual average precipitation is 51 inches per year, and the average yearly snowfall is approximately 70 inches.

Table 2. Population Demographics of Red Brook's Watershed Communities 2010

Town	2010 Population	Population Aged 0-24	Population Aged 25-64	Population Aged 64+	Median Household Income	Per Capita Income
Scarborough	19,234	30%	55%	13%	$55,491	$26,321
South Portland	23,324	30%	55%	14%	$42,770	$22,781

3.4 Surficial Geology and Soils

The surficial geology in the watershed area is the result of the advance and retreat of glaciers at the end of the last glacial period. The major soil type in the watershed is a fine-grained glaciomarine deposit with minor deposits of coarse-grained glaciomarine and till soils. The fine-grained glaciomarine sediments accumulated on the ocean floor when the lowland area of Southern Maine was submerged. The coarse-grained glaciomarine sediments were deposited where glacial meltwater streams and currents entered the sea. These sediments formed deltas, fans and kames, and locally covered earlier glaciomarine deposits of silts and clays. The till deposits, that are composed of heterogeneous mixture of sand, silt, clay, stones and may include boulders, were deposited directly from the glacier.

Red Brook above Kala Lane

Surficial Soils

The soils in the landscape within the watershed are composed of two groups of soil types; Windsor-Hinckley-Deerfield group and Hollis-Windsor-Au Gres group.

Within the limits of the watershed, the Hollis-Windsor-Au Gres group is the major soil group and located from the easterly limit, westerly to the Eight Corners area near the Gorham Town line. This group is described as shallow, somewhat excessively drained, gently sloping to steep, moderately coarse textured soils and deep, excessively drained and somewhat poorly drained, level to steep, coarse-textured soils. The major soils in the Hollis-Windsor-Au Gres group are characterized as shallowness to bedrock, a high water table and rapid permeability.

The Windsor-Hinckley-Deerfield group is located from the Eight Corners area to the westerly limit. The Windsor-Hinckley-Deerfield group is described as deep excessively drained to moderately well drained, nearly level to steep, coarse-textured soils. The major soils in the Windsor-Hinckley-Deerfield group have a rapid permeability and a seasonal high water table. Due to the rapid permeability groundwater contamination can occur where many septic tank systems are used in a densely populated area.

3.5 Historical Land Uses

During the 1920's, children ice skated on Clark's Pond and continued right up through to Pollywonkie Pond on Red Brook. Pollywonkie, as it was known locally, was approximately a half mile upstream of Clark's Pond on Red Brook and was a popular, year round recreational spot for weekend fun. Some of the best quality ice was harvested from local ponds in this area by the Portland & Sebago Ice Company. Around this time, land in the Red Brook Watershed was mostly used for agriculture.

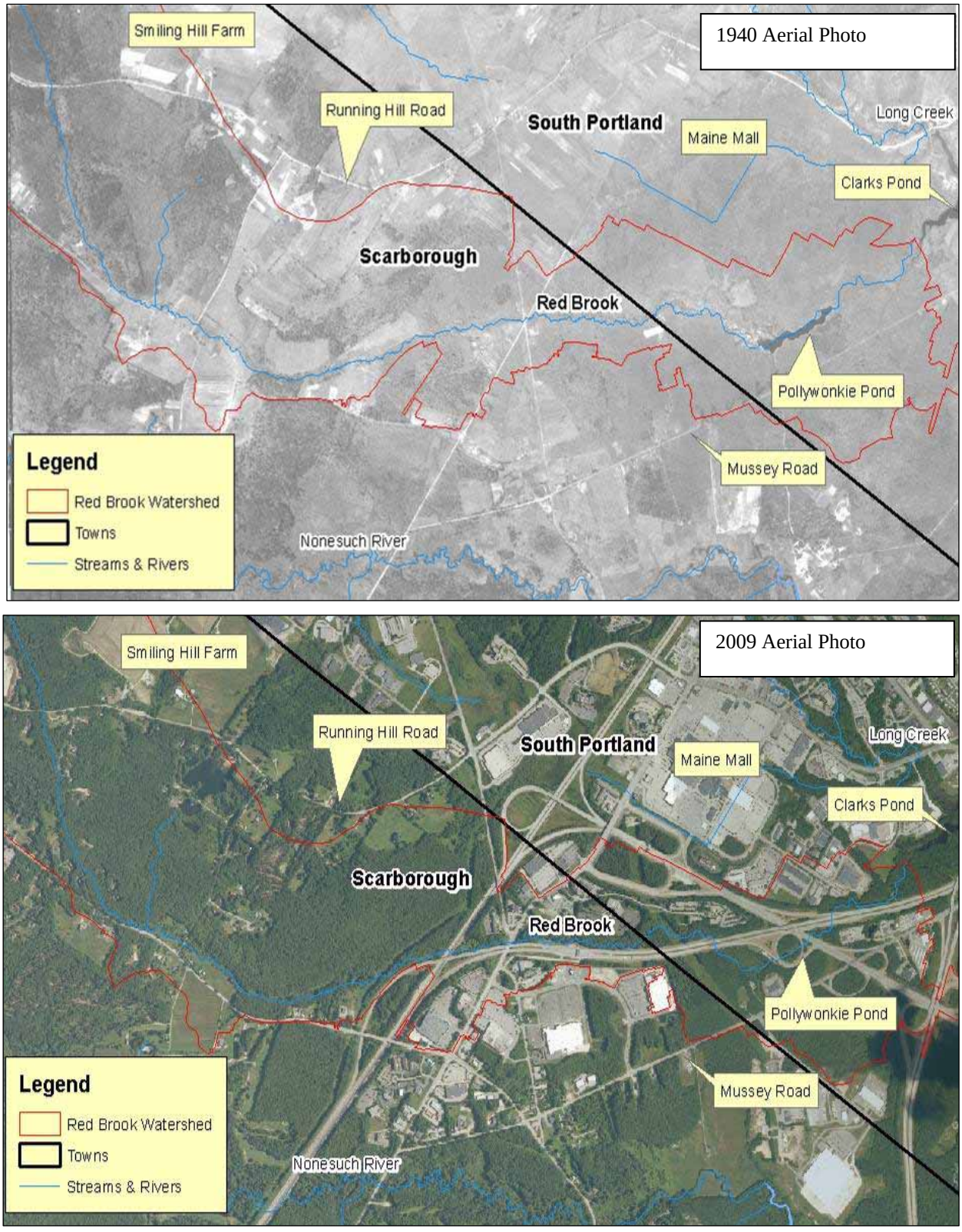
1890 - Ice Harvesting on Clarks Pond

In the 1940s the local economy and land use started changing. At the start of the war, the demand for liberty ships increased significantly, and the local shipyard provided many jobs. In the mid 1940s, construction of the Maine Turnpike began, and by 1946 Pollywonkie disappeared beneath Exit 7. In order to accommodate the new road, Red Brook's channel also needed to be moved and realigned. Then the 1960's brought the construction of Interstate 295 as well as the start of growth of the Maine Mall and surrounding area. Industrial and commercial operations and office complexes in the surrounding area continued with development expanding to most of the watershed on the east side of the Maine Turnpike.

3.6 Land Use Effects on Red Brook

The effects of this construction over the past several decades and the channel realignment produced large amounts of sediment that entered into Red Brook, Long Creek and Clark's Pond. Before the 1970's, there were no requirements in place to stop or control erosion from development and construction sites. Although Red Brook continued to be a good fishing spot for local anglers, the cumulative impacts to the brook were unknown at the time. *(See Figure 2)*

Figure 2. 1940 and 2009 aerial comparison



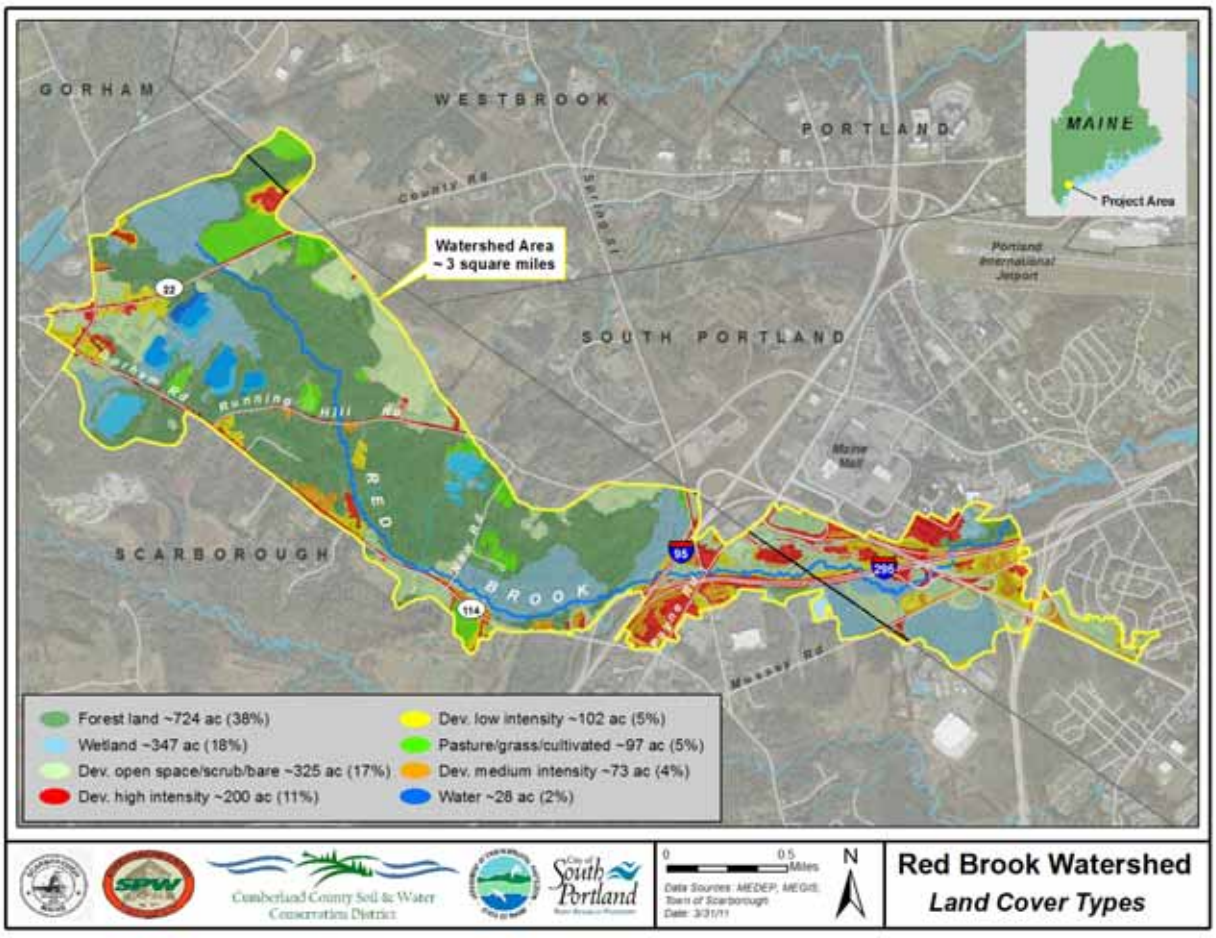
3.7 Current Land Use

In the Scarborough portion of the watershed, the Maine Turnpike (I-95) is currently the dividing line between the more developed and impervious portion of the watershed and the more rural, wooded and pervious area. The land area of the watershed east of the Maine Turnpike is more limited (460 acres) than the more rural, upper reaches of the watershed (1436 acres).

The area east of the Turnpike consists of a relatively high density commercial development with retail, restaurant, office and lodging facilities and the associated parking lots and driveways. In addition, this area of the watershed also includes a portion of the I-295 highway corridor and associated interchanges, the Maine Turnpike (I-95), the connector road from I-95 and I-295 to Route 1 in South Portland, and Payne Road.

The majority of the commercial development in Scarborough has occurred since the late 1980s as growth and development spread south into Scarborough from the Maine Mall area. Most of the developable land in this part of the watershed has already been developed. There are a few properties that are either undeveloped or underdeveloped, but the total developed and impervious area is not likely to increase dramatically due to future development.

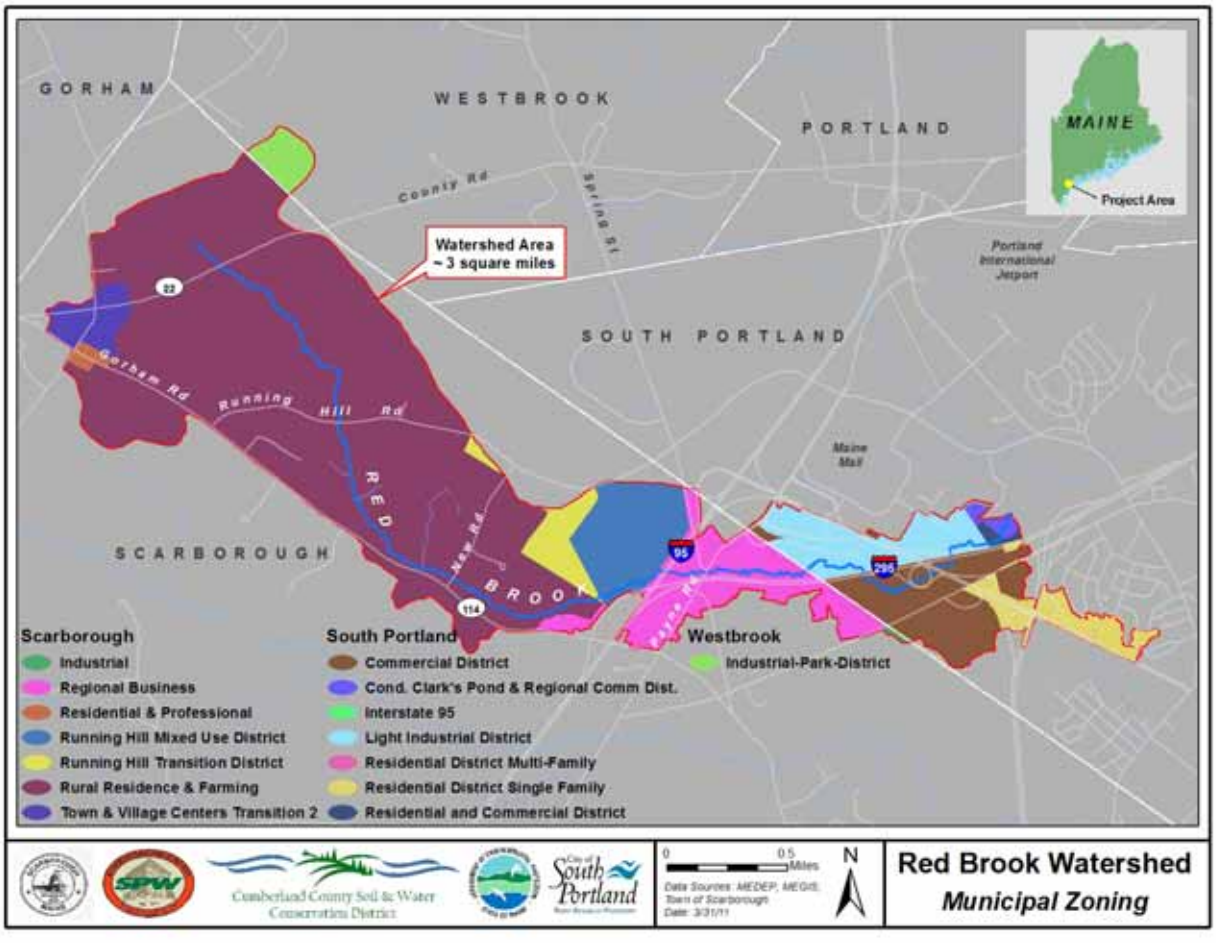
Figure 3. Red Brook Watershed Land Cover



The west side of the watershed (west of the Maine Turnpike) is currently relatively rural with a large amount of forested and open land with scattered suburban residential development along Running Hill Rd, Gorham Rd (Route 114), and County Rd (Route 22). In addition, there is a small village center in North Scarborough that includes some commercial and warehousing type development. The upper watershed also includes a large agricultural operation (Smiling Hill Farm) and the ecoMaine facility, a non-profit waste management company owned by 21 municipalities, which straddles the Red Brook and Long Creek watersheds.

As discussed in section 3.7 Current Land Use, the area of the watershed that is located west of the Maine Turnpike remains relatively rural and exhibits significant development potential. This development potential exists primarily in the Running Hill and North Scarborough growth areas. The Running Hill growth area has been zoned for relatively high density mixed use development, which could result in fairly intense commercial and residential development with significant impervious coverage. The North Scarborough growth area is zoned to be less intensely developed than Running Hill, but is also likely to experience additional development, redevelopment and infill over existing conditions. The following maps help illustrate the current impervious coverage within the watershed as well as the impervious "build out" potential. These maps are important aids in helping to understand the allowances under the Town's zoning,

Figure 4. Planning and current zoning areas for Scarborough and South Portland



but are very conservative models that do not deduct land that is challenging or unlikely to be developed. As illustrated on the maximum percent impervious surface by zone map, the areas shown in red in the western portion of the watershed have the most potential for impervious coverage, up to 80% or more in coverage. These areas consist of the two growth areas mentioned above, where more urban and village-style development is permitted. The larger area shown in orange in the upper reaches of the watershed illustrates the potential for 26% to 64% impervious coverage, which is allowed under the Rural and Farming District, but very unlikely given the rural development pattern typical of this zone and setting. (Figure 4).

3.8 Existing Transportation Infrastructure

The transportation infrastructure within the watershed includes over 22 miles of roads that range from arterials to collectors to local and private facilities. Ownership and maintenance responsibilities of the various roads are managed by the State, quasi-municipal (MTA), municipal and private entities depending on the specific facility. Those portions of the State facilities that are designated as "Compact Area" are maintained by municipalities, as required under state statutes. Table 3 summarizes the mileage for each classification and percentage of the total mileage in the watershed.

Table 3. Road Classification and Mileage

Road Classification	Total Mileage[1]	% of Total
Principal Arterial Interstate	5.57	25
Principal Arterial-other Federal	5.29	23
Minor Arterial	5.30	24
Major/Urban Collector	2.16	10
Minor Collector	0.09	<1
Local	3.06	14
Private	0.94	4
Total	**22.41**	**100**

[1] Mileage is based on road centerline distance and does not reflect the added length of each lane in multilane roads.

The approach to maintenance of these roads is, in part, governed by the typical road setting; (i.e. rural or urban). The typical road section in the watershed is predominately rural. Approximately 2.3 miles of the total 22.41 miles of road is urban with curbing and a significant enclosed stormwater collection system with point-source discharge of runoff from the roadway to receiving waters at low points. A road typically includes side-slopes from the travel way to direct stormwater to road-side grass ditches to the discharge points at receiving waters; again, based on the topography of the area. However, the principal arterials are divided highways that have pipe collection systems for the grass medians of those highways and/or include side slopes from the travel way to direct stormwater to road-side grass ditches to the discharge points at receiving waters.

For those roads the Town of Scarborough is responsible for, the public works department performs all aspects of annual road maintenance. The operations performed include:

- Minor road surface repair,

- Sub surface drainage infrastructure repair and maintenance,
- Surface drainage repair and maintenance, such as ditching,
- Signage and pavement markings,
- Traffic signal repair and maintenance,
- Road side grass and weed control.

All tasks performed by the Department of Public Works adhere to the latest standards and practices for the given operation. It is anticipated that maintenance of the other roads is accomplished in a similar way commensurate with the specific needs of each road.

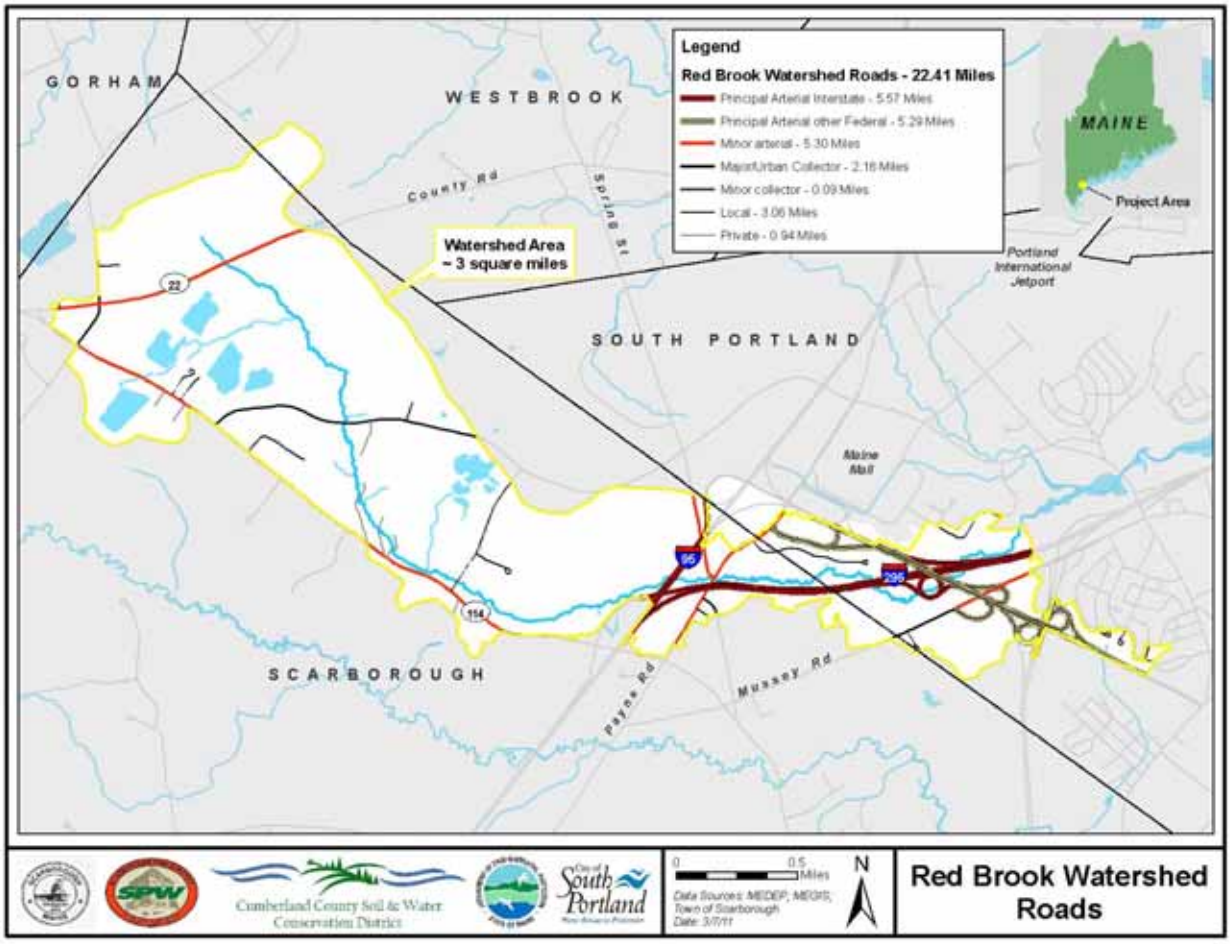
3.9 Future Transportation Plans

Growth management efforts in Scarborough and the Portland metropolitan region have led to two transportation plans that may occur within, and in the vicinity of the Red Brook watershed.

Locally, as a result of the Town's comprehensive plan, a growth area for small mixed use development with a relatively moderate to high development density was identified and rezoned in a portion of the watershed just west of the Maine Turnpike. With these changes, the Town of Scarborough initiated a transportation study to identify the transportation needs to serve the new land use of this growth area. The results of that study is a draft report titled *Running Hill Road Corridor Study Scarborough, Maine, November 2010*, prepared by Traffic Solutions, in association with Gorrill-Palmer Consulting Engineers. That study identifies a series of possible improvements including a new road corridor alignment from Gorham Road to Running Hill Road as well as intersection improvements to redirect traffic and add capacity to other existing intersections nearby. These improvements would likely be phased in over time to meet the increasing traffic demand during the build-out period. However, the new road alignment would likely be constructed first and would connect Gorham Road to Running Hill Road and would act as the backbone for access to the growth area. This alignment would necessitate the crossing of Red Brook, near Gorham Road.

On a metropolitan regional basis, in co-operation with Maine DOT, MTA, Portland Area Comprehensive Transportation System (PACTS) and the core communities of Gorham, Westbrook, Scarborough and South Portland a major east-west transportation corridor and land use study was initiated in April of 2009, titled *Gorham East-West Corridor Feasibility Study*. "The study's goal is to evaluate all options and – without adding excess transportation capacity – find the right combination of sustainable land use and transportation solutions that can be implemented between now and 2035 to protect area residents' quality of life." The Gorham East-West corridor study has issued an executive summary of the results with recommendations for land use and transportation facilities in the study area. Within the Red Brook watershed, the transportation recommendations include widening Route 114 to 4-lanes, a non-toll bypass of Payne Road and a new highway corridor near MTA exit 44/45 westerly to Gorham. The next step for the study is the execution of a memorandum of

Figure 5. Red Brook Watershed Roads



understanding (MOU) to further develop and refine the recommendations of the study.
Figure 5. Red Brook Watershed Roads

There are a number of road segments within the Red Brook watershed in Scarborough that are state aid roads. Roads within the watershed designated other than local are the responsibility of the Maine DOT and Maine Turnpike Authority-MTA. Both will include Red Brook watershed roads when any major expansion, reconstruction or improvement projects are contemplated.

4. Water Resources

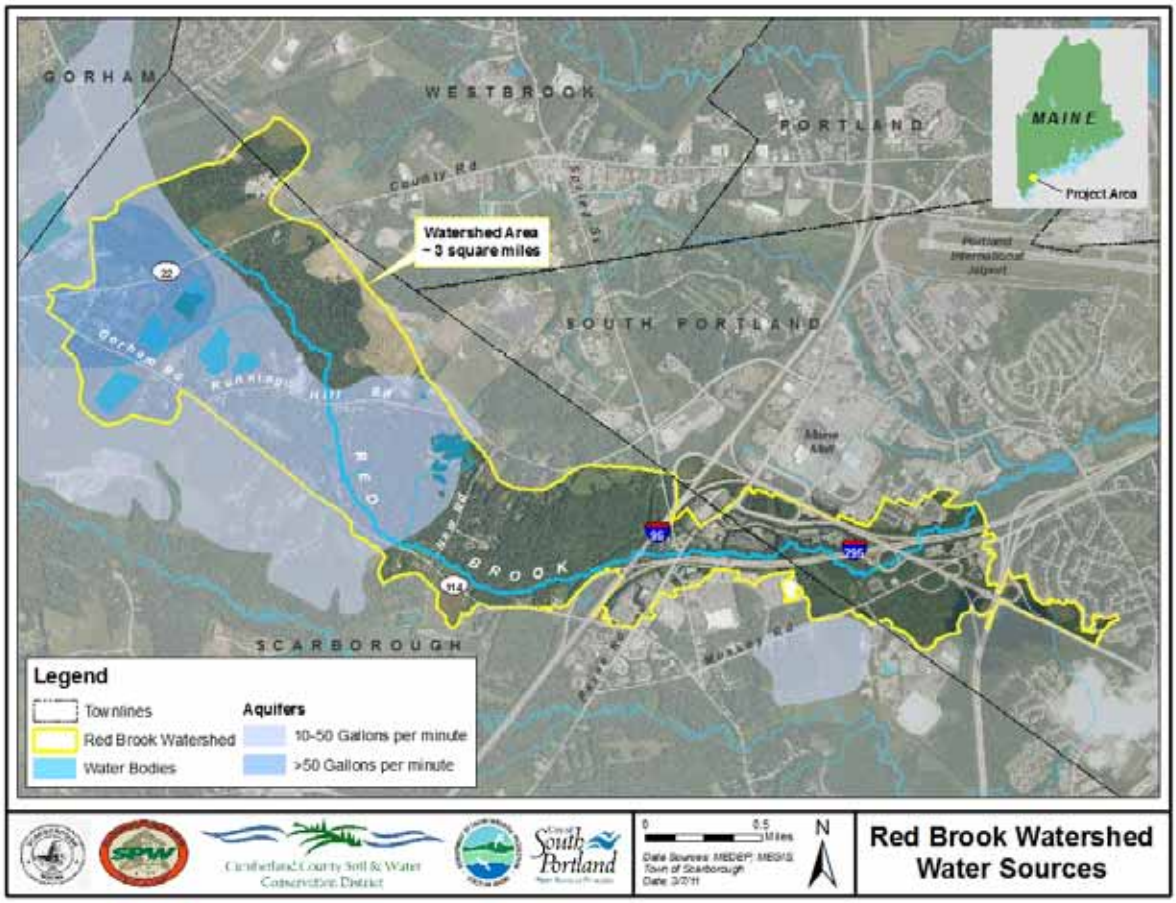
4.1 Streams

Red Brook is a small freshwater stream that flows southeast in the Town of Scarborough for approximately 7.15 miles and empties into Clark's Pond in South Portland. There are numerous unnamed tributaries to the stream. A handful of these tributary streams appear to flow year-round (perennial), but many more are smaller, intermittent streams. The biological habitat in the immediate vicinity of the stream is called a riparian zone. Streams are important as conduits in the water cycle, groundwater recharge and corridors for fish and wildlife migration. Streams play an important role in connecting fragmented habitats.

4.2 Ponds

There are several groundwater-fed, man-made ponds in the upper watershed. The five larger ponds located north and west of Running Hill Road were excavated in the late 1960s and early 1970s for gravel to build Route 295. These ponds range in size from about 6.2 to 12.5 acres. A smaller series of ponds by New Road were also former gravel pits, but they were created prior to the Route 295 work (Personal Communication, Warren Knight). The largest of these ponds is about 8.7 acres, and the other five range from 0.4 to 1.5 acres. Since they are artificially created and less than 30 acres in size, these ponds are not protected as Great Ponds under the Natural Resources Protection Act (NRPA). However, some may be classified as wetlands or have associated wetlands, which would be protected under the law.

Figure 6. Red Brook Watershed's Water Resources



4.3 Groundwater Aquifer

When groundwater can be pumped to the surface fast enough to be economically useful, the saturated soil or bedrock is called an aquifer. Sand and gravel aquifers store water in the pores between the grains of sand and gravel that were deposited during the last glacial occupation and retreat more than 10,000 years ago. These aquifers can hold and transport large volumes of water quickly, making them the most valuable groundwater aquifers with the most abundant

yields. Scarborough's largest high-yield aquifer lies under a large part of North Scarborough in the Red Brook watershed.

4.4 Stream Class and Criteria

The Maine Legislature (Title 38 MRSA 464-468) has established water quality classification standards for all surface waters in the State of Maine. This system provides water quality goals and criteria and guides management efforts so that individual water bodies can be protected and restored to meet these goals. Although all water bodies must meet fishable and swimmable goals in the Federal Clean Water Act, four classes of freshwater streams (AA, A, B and C) have been established to reflect differences in risk. This ranges from Class AA streams, which are in the most natural condition and highest water quality criteria, to Class C streams, which are still good quality but have a higher risk of degradation (Table 4 - list Criteria for Class B & C only).

The state classified all of Red Brook as Class C. Streams in this class must support aquatic life and allow for other designated uses such as drinking water, fishing and recreation. In addition, Class C streams must meet specific criteria for dissolved oxygen, bacteria, habitat and aquatic life. These criteria are less stringent for Class C streams compared with Class B streams.

4.5 Reasons for Stream Impairment

Table 4. Maine Stream Classifications, Designated Uses and Criteria

	Designated Uses	Numeric Criteria	Habitat Narrative Criteria	Aquatic Life (Biological) Narrative Criteria**
Class B	Aquatic Life; Drinking Water; Fishing; Recreation; Navigation, Hydropower; Industrial Discharge	**Dissolved Oxygen** 7 ppm and 75% saturation **E. coli** 64/100 ml (g.m.*) or 236/100 ml (inst.*)	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	Aquatic Life; Drinking Water; Fishing; Recreation; Navigation, Hydropower; Industrial Discharge	**Dissolved Oxygen** 5 ppm and 60% saturation **E. coli** 126/100 ml (g.m.*) or 236/100 ml (inst.*)	Habitat for fish and other aquatic life	Discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community. **

* "g.m." means geometric mean and "inst." means instantaneous level

**Determined using numeric biocriteria through Maine DEP's Biological Monitoring Program

According to the Integrated Water Quality Monitoring and Assessment Report (DEP, 2010), Red Brook does not meet Class C designated uses and criteria (Table 6). Specifically, it is listed as impaired because it does not meet the designated use for fishing due to PCB contamination, and it does not provide for aquatic life due to stream habitat problems in the lower section of the stream below Payne Road. All other Class C criteria and uses are currently met.

5. Water Quality and Biological Assessments

5.1 Overview of Stream Assessments

Over the past 15 years, several assessments have been conducted on Red Brook. The Maine Department of Inland Fisheries and Wildlife (IF&W) and Maine (DOT) have collected data on the stream's fish populations. The DEP has conducted water quality and biological monitoring in Red Brook every five years as part of its biological monitoring Program. Red Brook was also a part of the DEP's urban stream study, which collected extensive data from 1999—2000. Findings from this study were reported in *A Biological, Physical, and Chemical Assessment of Two Urban Streams in Southern Maine: Long Creek & Red Brook* (Maine DEP, 2002). As part of the watershed management planning process, project partners collected additional data to try to fill data gaps and find answers to remaining questions.

The following section (Table 5 & 6) and Appendix C summarizes this body of data and highlights the areas of impairment and possible future problems. Figure 7 shows the approximate locations of the monitoring sites mentioned in the following section. Note that past studies often used different site numbering, but we have renamed the locations for purposes of clarity.

Table 5. Red Brook Designated Uses and Associated Criteria

Designated Uses	Criteria	Status
Aquatic Life	Biomonitoring criteria	Meets
	Stream habitat	**Does not meet**
	Dissolved Oxygen	Meets
	Support of indigenous species	Meets
Fishing	Supports indigenous fish species	Meets
	No consumption advisory	**Does not meet**
Recreation	E.coli bacteria	Meets

5.2 Biological Assessments

5.2.1 Biomonitoring Data

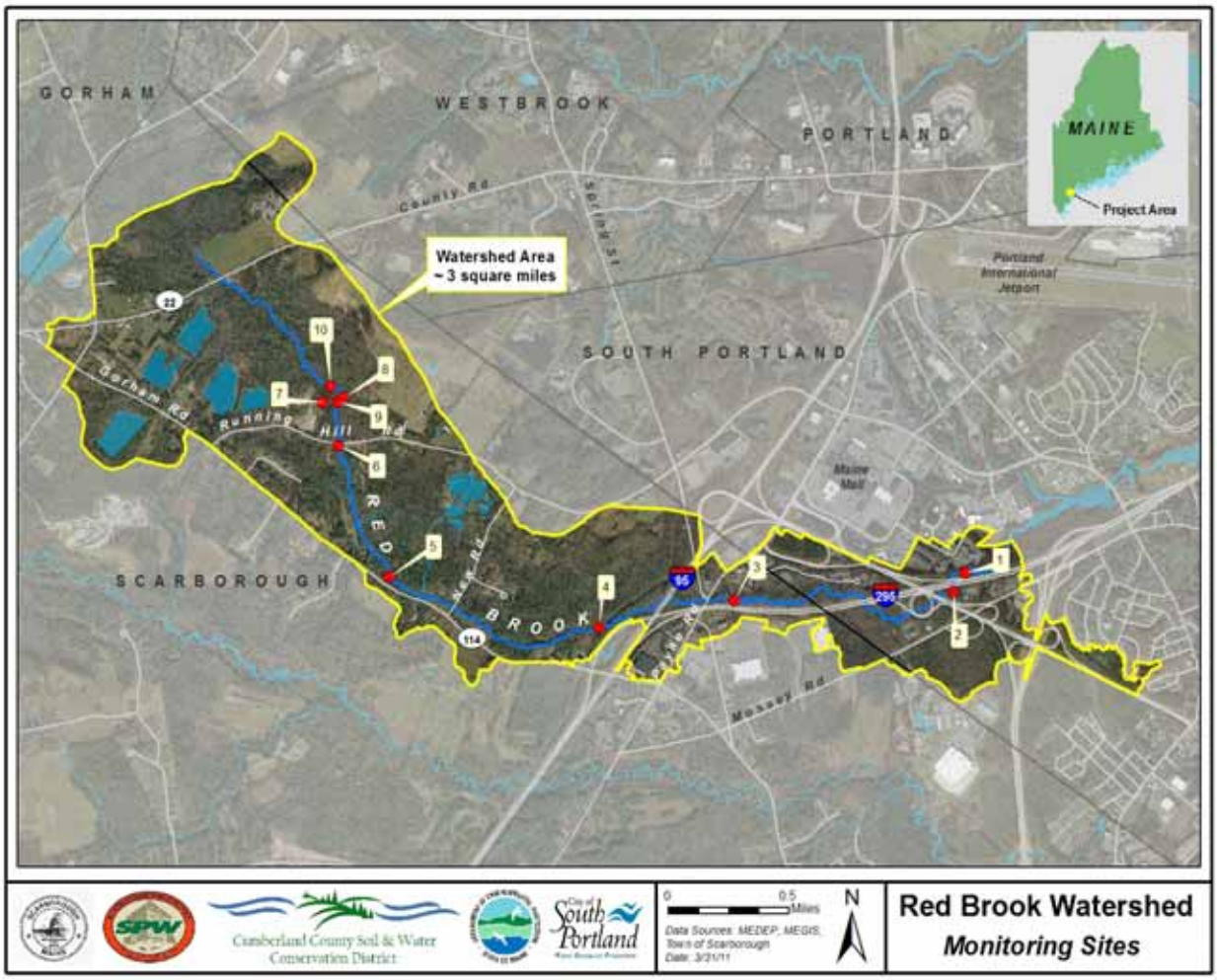
The Maine DEP's Biological Monitoring Program (also known as Biomonitoring Program) collects and analyzes aquatic macroinvertebrate samples from rivers and streams. The Program uses a statistical model to determine if rivers and streams are meeting the aquatic life

criteria associated with their assigned legislative water quality class (AA, A, B, or C).

Table 6. Summary of Biological Assessments at Red Brook Monitoring Stations

	Station 1 Clark's Pond	Station 2	Station 3 Payne Road	Station 5 Reference	Station 10 Reference
Biomonitoring	good	good	**good/fair**	good	excellent
Brook Trout	**good/fair**	**good**	**good/fair**	good	good

Figure 7. Red Brook Monitoring Sites



The Biomonitoring Program collected nine macroinvertebrate samples from Stations 1, 3, 6 and 10 in Red Brook in 1994, 1999, 2005, 2007 and 2010. The data collected in 1999 was part of the DEP Stream Study. Based on this data and the model, Red Brook met (or exceeded) Class C biomonitoring criteria in 9 of the 12 samples. The site below Payne Road met Class B standards in 2007, and the station above Running Hill Road even met Class A standards in 1999.

The 1999 sample at Station 3 was 'indeterminate' because the collected rock bag was 60% buried in sand and the model could not be run with confidence due to low abundances of organisms in the sample. The 1999 sample at Station 6 initially indicated that the stream did not meet Class C standards. A second sample was collected, however, and it showed that the stream did indeed meet Class C standards for aquatic life.

5.2.2 Fisheries and Brook Trout Population

Aquatic life criteria requires that all stream classes must support native indigenous fish species, and brook trout are considered indigenous to all flowing Maine streams. Red Brook has historically been valued by local residents for its brook trout fishery, and there is ample evidence that Red Brook continues to meet this criteria.

According to Francis Brautigam of the IF&W, the last time brook trout were stocked in Red Brook was 1974, so the current existing population is believed to be a self-sustaining population. Maine IF&W conducted electrofishing at Site 4 in 1983 and Sites 3 and 5 in 1987 and found listed brook trout as 'abundant' in both surveys (www.pearl.maine.edu). The two DEP Streams Study (2002) conducted an electrofishing survey at Stations 1, 3, 4 and 10 in 2000. Although brook trout were not found at Station 1, they were abundant at the three upstream stations. On June 30, 2010, Maine DOT conducted an electrofishing survey and found brook trout at all four stations surveyed (Maine DOT, 2010). Brook trout were abundant at Sites 2, 3 and 5 and 6 however, only one trout (11 inches long) was present at Site 3, which is located below Payne Road.

- Site 2 - which is the furthest downstream sampling point closest to Clarks Pond was well shaded, had shallow riffles, somewhat armored substrate and pools. Approximately 150' of this reach was surveyed and 6 brook trout and 3 blacknose dace were found.
- Site 3 - located just downstream of the Payne Road crossing found riffles and deep pools and approximately 150' of the reach surveyed and found 2 black nose dace, 5 white suckers and 1 brook trout.
- Site 5 - located at the crossing of Kala Lane just off of the Gorham Road found a sandy substrate while surveying a 60' reach. Four brook trout were found and no other species.
- Site 6 - located at the Running Hill Road crossing found a sandy substrate in this 150' reach. Seven brook trout were found and no other species.

5.2.3 Summary of Biological Assessments

Red Brook meets Class C aquatic life standards for biomonitoring and supporting indigenous fish (i.e., brook trout) populations, and Station 10 has even met Class A biomonitoring standards. That said, the stream's aquatic life is showing some signs of stress in the eastern watershed. Electrofishing surveys have found significantly fewer brook trout at two of the stations in this eastern portion of the watershed. One of the 1999 biomonitoring samples was indeterminate because it was 60% buried in sand and too few organisms to be run correctly through the statistical model.

5.3 Stream Habitat and Geomorphology Assessments

5.3.1 Stream Habitat Background

Class C streams must provide habitat for fish and other aquatic life. Red Brook is listed as impaired because portions of Red Brook did not meet this aquatic life criteria. (Table 7) To support fish and other aquatic life, stream habitat should include the following components: a wide variety of pools, fast-flowing riffles, large woody debris, overhead tree canopy and stable stream bottom (Maine DEP, 2010). These features create diverse conditions required by

Table 7. Summary of Stream Habitat and Geomorphology in Red Brook

	Below the Turnpike	Above the Turnpike
Stream Canopy	good	good
Bank, Channel and Floodplain Erosion	**poor**	good
Woody Debris	**fair/poor**	good
In-Stream Pools	**poor**	fair
Channel and Floodplain Modification	**common**	none
Channel constriction by culverts	**poor**	

different aquatic organisms for survival and reproduction. Pools and large wood in streams help trap food and provide cover and refuge for creatures. Stable stream beds covered with gravels provide spawning areas and homes to diverse macroinvertebrates. Canopy trees shade streams, and fallen leaves provide food for aquatic organisms.

As watersheds become more urbanized, stream habitat is often degraded and destabilized. Construction activities adjacent to streams can remove tree canopy and relocate or artificially armor stream channels. As impervious surfaces increase in the watershed the changing flow regime can increase streambank erosion; increase sedimentation in pools and spawning areas; and destabilize the stream bottom and large woody debris. Fluvial geomorphology is the study of the shape and stability of river and stream systems. Although all streams change over time, human disturbance can destabilize the natural equilibrium in stream systems. The rates and volumes of in-stream and bank erosion increases dramatically with significant increases in the amount of stream flow (by increasing impervious surfaces and runoff) or increases in the amount of sediment reaching the stream (by construction activities, road sanding etc.). This instability is closely related to stream habitat conditions.

5.3.2 Stream Habitat and Geomorphology Survey Results

Stream habitat and geomorphic surveys were conducted in 1999 and 2010 on several reaches of Red Brook. A 2010 stream corridor survey also documented locations of streambank and floodplain erosion and assessed the stream's 15 culverts for fish passage issues using methods in the Maine Road Stream Crossing Manual (2008). Geomorphology assessments evaluated

Red Brook's natural stream conditions, identified segments where human activities have affected the stream and proposed ways to restore the stream to a more stable condition. Stream habitat surveys included woody debris counts, measurements of stream shading, habitat scoring, and stream bottom 'pebble counts'.

In both the 1999 and 2010 habitat surveys, canopy cover at all seven study reaches was very good with over 90% stream shading. The 1999 geomorphology study found that most of the stream above the Maine Turnpike was relatively stable with a high degree of stream sinuosity, instream woody debris and streambank stability (DEP 2002). Probably due to the low gradient and underlying sandy soils, DEP found that none of the reaches (even above the Turnpike) had plentiful stable substrate or pool diversity (DEP, 2002). Below the Turnpike, however, studies have documented signs of stress and instability compared to the upper reaches. Some of the observed habitat and stream stability problems below the Turnpike include:

- **Channel Alteration** - Both geomorphology studies identified sections of stream that have been altered in the past due to past construction. These areas have ongoing impacts on stream habitat. Channel modifications include the following: at least two sections where streambanks have been armored with riprap (large stone); one area just above Payne Road where the floodplain has possibly been filled; and two areas where the stream or tributaries have been straightened or relocated to accommodate road construction. (Seeley & Valle 1983)

Table 8. Summary of Water Quality at Red Brook Monitoring Stations

Pollutant	Station 1 Clark's Pond	Station 2	Station 3 Payne Road	Station 5 Reference	Station 10 Reference
Dissolved Oxygen	good	good	**good/fair**	good	Good/excellent
Specific Conductivity	good	**good/fair**	**good/fair**	good	Good/excellent
Metals	good		good		good
PAHs			good		
E. coli bacteria	**1 high sample**		good		good
Oil and grease	good		**detected**		good
Nutrients	good		good		good
Water Temperature	good		**good/fair**	good	good

- **Stream Bank, Channel and Floodplain Erosion** - In the 1999 rapid habitat assessment, there was significantly more sediment deposition observed in the eastern portion of the watershed compared to Site 10 above Running Hill Road (DEP, 2002). In a Pfankuch channel stability study, all three segments in the eastern portion of the watershed below the Turnpike were rated as 'poor', while Site 10 was rated as 'fair' (DEP, 2002).

Severe bank erosion was noted in the eastern portion of the watershed in both the habitat, stream corridor and geomorphology surveys, and at Station 3 (below Payne Road), one rock bag sample was 60% buried in sand in the month that it was placed in the stream. The 2010 geomorphology study also identified several streambank erosion and floodplain incision problems caused by drainage pipes discharging stormwater runoff into the channel and on the floodplain.

- **Lack of Woody Debris -** The 2010 stream habitat survey tallied the pieces of large woody debris (over 10 cm. diameter) at reaches by Stations 1, 3, 4 and 10 and found that the two 150 meter reaches below the Turnpike had significantly less wood (28 pieces each) than the two segments in the western portion of the watershed (43 and 38 pieces). The wood in eastern portions tended to be smaller and shorter than the wood in western portions. The DEP's 1999 woody debris survey, which counted pieces of wood over 5 cm. diameter, also found significantly fewer logs in the eastern reaches (61 pieces) compared to the one in the western reaches (91 pieces).

  The 2010 geomorphology study also noted that the removal of wood and other structural elements from the channel has degraded physical habitat elements in the channel and caused minor channel incision that has dried out floodplain side channels during low-flow periods.

Summary of Water Quality Conditions

Based on the water quality information collected over the past 11 years, it appears that Red Brook is in relatively good condition, and above the Maine Turnpike the stream is in excellent condition (Table 8). The stream meets Class C water quality criteria for DO, E. coli bacteria and metals, and nutrient levels also appear to be low at all stations. That said, Red Brook's water quality is showing some signs of stress below the Maine Turnpike with higher temperatures, lower dissolved oxygen, higher specific conductivity and at least one instance with high E. coli bacteria and oil and grease in samples.

- **Culvert Impacts** - The 2010 geomorphology study found that several of the eight culverts from the Turnpike and downstream are constricting stream flow and causing deposition of fine sediment upstream and bed scour and bank erosion downstream. In the 2010 Stream Road Crossing Survey, 4 of the 15 assessed culverts were also identified as significant fish passage barriers.

5.4 Polychlorinated Biphenyls (PCBs)

5.4.1 Background

PCBs, or Polychlorinated Biphenyls, are a group of 209 similar chemicals that were first created in 1929 and were commonly used in manufacturing for fifty years. PCBs help make materials more heat resistant and flexible, and they were added to caulking, sealants, adhesives, paint, electrical transformers, lubricants and cutting oils. Due to the toxic effects to human health and the environment, PCB production in the United States was banned in 1979.

Despite the phase out, PCBs still pose a persistent environmental problem in many areas since they do not break down easily on their own; they are difficult to destroy; and they bioaccumulate (or build up in animal tissues) once they enter the food chain. Even in rural Maine, there are trace levels of PCBs due to atmospheric deposition. However, elevated PCB levels have been found in several Maine rivers and streams below industrial areas where PCBs were used in manufacturing.

5.4.2 PCB Levels in Red Brook

The Maine Center for Disease Control and Prevention (CDC) sets action levels to determine when to issue fish consumption advisories for certain waters. Action levels are the concentrations of a contaminant in fish tissue below which there should be negligible risk of negative health effects. The action level for PCBs is 11 parts per billion (ppb) (Maine CDC 2001).

Fish tissue from brook trout in Red Brook has been collected and analyzed three times since 1994, and PCB levels have exceeded the CDC action level each time. PCB levels were 60.2 ppb in 1994, 21.6 ppb in 2000, and 60 ppb in 2009 (SWAT 2000 and DEP files). Based on these elevated levels, the Maine CDC has issued a fish consumption advisory for Red Brook and recommends limiting consumption to 6 fish meals per year.

5.4.3 Possible PCB Sources and Past Mitigation

In past DEP 305(b) reports, Red Brook is listed as impaired due to contamination by PCBs caused by unspecified nonpoint sources. Although specific PCB sources into the stream have not been identified, PCB problems are typically found downstream of sites with past industrial activity. Red Brook's upper watershed includes several industrial parcels that could have used or stored PCB-tainted materials and at some point contributed PCBs to Red Brook. Since PCBs are not water soluble, it is unlikely that they reached the stream through groundwater or surface water flows to the stream. Instead, PCBs bind tightly to soil particles and likely reached Red Brook along with contaminated sediments that washed into the stream and then were ingested by aquatic organisms at the base of the food chain.

Although there is no conclusive evidence that it was a source to the stream, PCBs have been documented in one location near Red Brook just above Running Hill Road. A former salvage yard, owned first by M. Silver and Sons Scrap and then E. Perry Scrap, accepted PCB-tainted metal turnings and electrical transformer waste. In recent years, new owners worked with the Maine DEP's Voluntary Response Action Program (VRAP) to investigate and clean up the property prior to redevelopment into a self-storage facility. Environmental consultants working for the property owner sampled soil around the property and found low-level PCBs in only two piles of soil on the property. In 2009 the contaminated material was stabilized through a chemical fixation process and encapsulated under concrete building foundations or pavement. Testing of the stabilized PCB contaminated soils demonstrated that the final product does not leach contaminants; post-remediation sampling demonstrated that all the PCB contaminated soils were stabilized.

Samples were collected from other areas on the property, but PCBs were not found

elsewhere. If the encapsulated PCBs were indeed the only source to Red Brook, then it would follow that PCB levels may now eventually decrease in fish tissue over time. Since PCBs are so long-lived in the environment, this could take several years to happen.

At the Red Brook Community meeting, residents expressed concerns that the ecomaine landfill and Larson-Chapman S.D. Warren landfill could be potential sources of PCBs to Red Brook due to their historical storage of industrial waste and proximity to the stream. There is no evidence this is the case. From 1974 to 1988, the Larson-Chapman S.D. Warren landfill was used for the disposal of paper-making waste consisting primarily of short paper fiber, clay sludge, paper and miscellaneous mill waste. The landfill was covered with soil in 1989 and further "capped" using a short paper fiber material in 2006. PCBs are not typically associated with short paper fibers, and no PCBs have been found at the site. The ecomaine landfill (formerly known as RWS) includes a closed balefill and two operating landfill/ashfills. Since PCBs are destroyed during incineration process and the balefill was closed using a geomembrane cap sealed in 1997, the current site is not a likely source of PCB contamination to the stream. Due to the prevalence of the PCBs in the waste stream in years past, PCBs could have washed into Red Brook from the balefill prior to closure. However, there is no evidence that this ever occurred.

Hanging fencepost shows severe bank erosion near Station 1.

EPA conducted a sediment study in 2010 to further investigate the concerns raised by the public about PCB sources to Red Brook. Four drainage channels extending from Red Brook to the ecomaine landfill, the Larson-Chapman S.D. Warren landfill and the former salvage yard were identified, and sediment from these channels was collected and analyzed for PCBs. (Figure 8.) EPA did not detect PCBs at any of the sites. Although this does not completely rule out the possibility that one or more of these sites are/were sources of PCBs to Red Brook, it does build the case that there is no ongoing PCB contamination to the stream and that the primary source has been addressed.

6. Management Plan Approach

6.1 Red Brook Habitat Restoration

Red Brook's habitat impairments are due both to past physical modifications to the stream channel and indirect impacts from ongoing stormwater runoff.

6.1.1 Addressing Physical Alterations to Red Brook

Many of Red Brook's identified habitat problems are the result of physical alterations to the stream during past road construction and development. Construction of I-295 during the

Figure 8. EPA Sediment Sites.

1960s removed vegetation and added fill adjacent to the stream, and portions of the stream were relocated to facilitate road construction (Seeley and Valle 1983). Intensive logging activities at the lower end of Red Brook also likely removed sources of wood to the stream (Seeley and Valle 1983). Many of the 12 culverts installed across the stream create flow constrictions, downstream erosion and fish passage barriers.

The 2010 fluvial geomorphology assessment conducted on lower Red Brook (below the Turnpike) provided the following recommendations for improving channel stability and aquatic habitat associated with these past alterations to the stream.

Culvert replacement or rehabilitation — Undersized culverts could either be replaced, resized, or supplemented with floodplain culverts. If replacement or additional culverts is cost prohibitive, weirs or other structures can also be added to reduce downstream scour and improve fish passage.

Addition of Wood to Channel—Where structure is lacking in the channel, wood and boulders should be placed in the stream channel to protect banks from erosion, create pools around their margins, segregate particles into different sizes, and induce greater overbank flow on the floodplain to enhance juvenile habitat in reactivated side channels.

The project's Technical and Roads Workgroup evaluated and prioritized specific stream culvert and wood addition restoration projects (See Appendix A & C). Since these projects are all closely tied to stream hydrology, they identified the need for hydrologic studies or modeling of the stream. Such a study would ideally be conducted for the entire stream. If this is not economically feasible, individual projects should be designed based on basic hydrologic modeling to make sure projects are feasible (i.e., additions of wood to the stream will stay in place) and prioritized and phased properly to provide the greatest benefits to stream habitat.

6.1.2 Addressing Stormwater Impacts

In addition to the physical alterations to the actual stream channel, stormwater from development adjacent to the stream corridor has also impacted Red Brook's habitat. Much of the commercial development near the stream dates back to the 1980s and 90s. At this time, State regulations required new construction projects to install detention ponds and other Best Management Practices (BMPs) for flood control. Although these BMPs did serve those purposes, they did not effectively protect small streams from impacts such increased temperatures or channel erosion from smaller storm flows.

As a result, the highly impervious areas in the lower part of the watershed have changed stream flows by directing large volumes of runoff directly to the stream. Some of the stormwater discharges directly into the stream in outfall pipes (see photo above). Other outfalls flow into road ditches, which in turn flow into the stream. Outfalls from several detention ponds drain onto Red Brook's floodplain. Floodplain and streambank erosion were observed below several of these outfalls.

6.1.3 The following strategies were recommended for dealing with these ongoing stormwater impacts to habitat.

Potential retrofit - opportunity areas within the Red Brook watershed were identified through preliminary analysis of high-resolution aerial photography, review of existing development stormwater infrastructure and consultations with representatives of the Town of Scarborough, City of South Portland, MDEP, MDOT and MTA.

The focus area consisted mainly in the areas that exhibit the greatest amount of impervious cover (IC) that receive little to no stormwater water quality treatment prior to discharging pollutants directly to Red Brook and its tributaries. The overall goals of the stormwater retrofit analysis 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 IC treated).

Impervious cover is any surface(e.g. roads, sidewalks, driveways, parking lots, and rooftops) that no longer absorbs rain and can direct large volumes of stormwater runoff into streams.

Dispersal of Stormwater Outfalls — Outfall pipes from several detention ponds are causing floodplain and streambank erosion problems. As described above, these detention ponds would ideally be retrofitted to provide, in addition to flood storage on very large storms, slow release of runoff from smaller, more frequent storms. This would likely be a very expensive option. As a low-cost alternative, flow from the outfalls of stormwater basins could be distributed into multiple pipes or allowed to spread over an expanding apron so that the discharge does not cause streambank or floodplain erosion. Wood can also be placed on floodplains below these outfalls to help disperse flows.

6.2 Preventing Future Impacts to Red Brook

6.2.1 Impacts of Development and Impervious Cover

Currently, Red Brook's impairments are limited to stream habitat and PCBs in fish tissue. The stream still supports a brook trout fishery and the aquatic macroinvertebrates that are expected to live in Class C streams. Without careful planning and protection efforts, however, these healthy populations will undoubtedly be at risk as the watershed continues to develop.

Studies in Maine and around the country show strong connection between stream health and the amount of development in a watershed. Impervious cover (IC) is a measure of watershed development and includes parking lots, roads, rooftops and other paved areas. A direct correlation has been established between IC and the health of aquatic ecosystems, specifically 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 (Center for Watershed Protection [CWP] 2003). (See Figure 9 & 9A for existing and potential Red Brook impervious cover).

Figure 9. Map depicts the maximum build out potential in the watershed if it were completely built out.

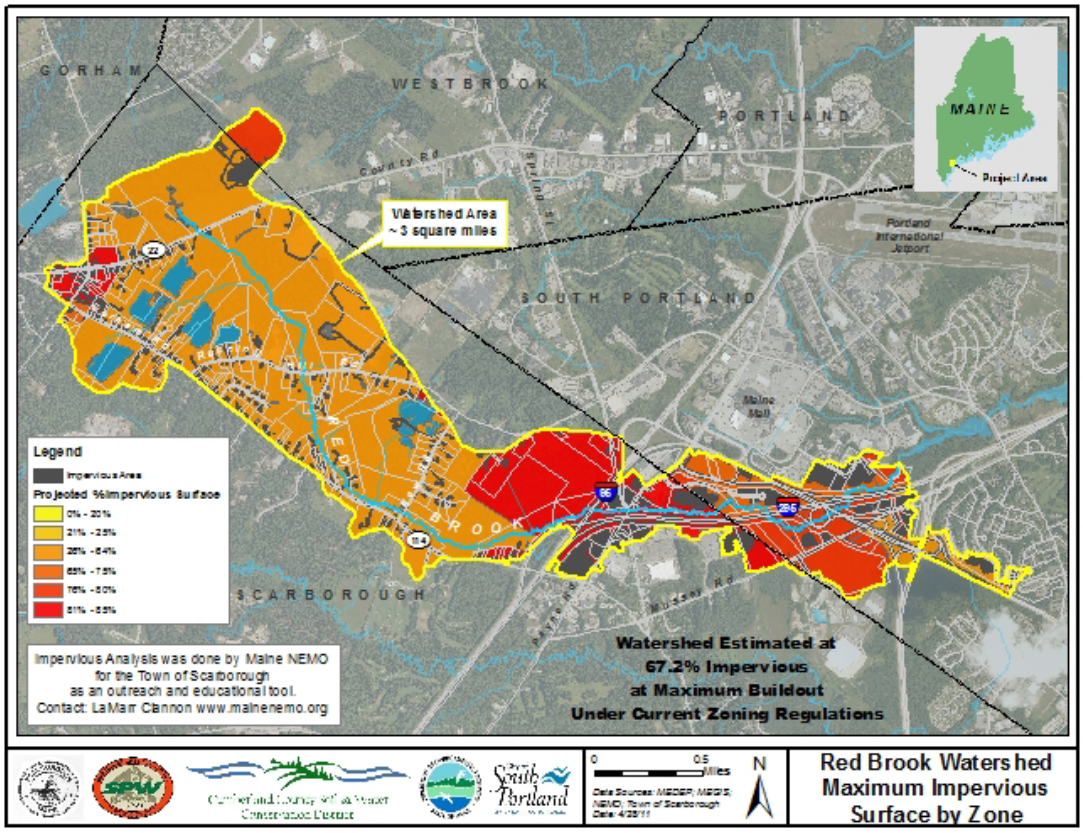
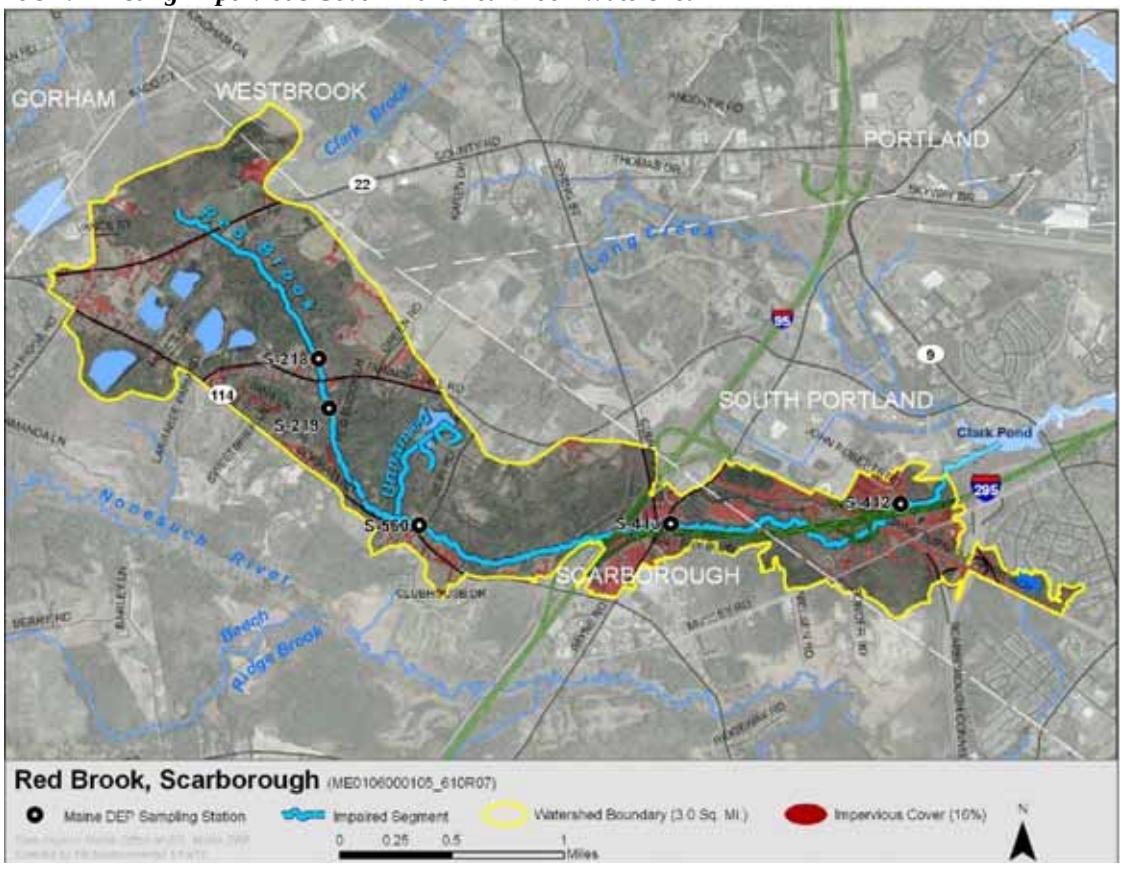


Figure 9A. Existing Impervious Cover in the Red Brook Watershed



Maine DEP's draft Impervious Cover TMDL (Draft 2011) found that Red Brook's watershed has impervious cover of 16% (although the lower section is much higher). The study also evaluated stream and watershed conditions and determined that Red Brook needs to have the characteristics of a watershed with 13% impervious cover. This indicates that techniques need to be used to minimize the impacts of impervious cover from both existing and future development to keep the stream healthy. New development, employing thoughtful consideration of stormwater planning and management would minimize the IC through good design of projects and keep existing hydrology as before a project was started, perhaps with low impact development practices.

Figure 10. Eight Tools of Watershed Protection

6.3 Protection Strategies

The Center for Watershed Protection (2000) recommends eight tools for watershed protection and restoration (Figure 10). For streams in sensitive/impacted streams like Red Brook, CWP emphasizes the importance of land use planning and stormwater management. Most of these tools were considered during the stakeholder planning process, and associated actions were developed and tailored to fit the watershed and community needs and resources. The eight tools and relevance to Red Brook are discussed briefly.

Land Use Planning - Since impervious cover has such a strong influence on subwatershed quality, choices should be considered about how and where to develop. According to the CWP, this is perhaps the single most important watershed protection tool.

Land Conservation - Land conservation efforts should aim to protect critical lands (such as stream corridors, wetlands, forested areas etc.) in the watershed that protect habitat and water quality. Local land trusts often have shared interests in these areas.

Stream Buffer Protection – A buffer is the vegetated area between the stream and developed areas that provides numerous benefits including flood control, wildlife habitat, filtering of pollution from stormwater and streambank stabilization. Local and state regulations limit activity in some buffers, but protection levels can be evaluated to make sure stream buffers are adequately protected.

Better Site Design - Urban development is often characterized by large amounts of impervious cover. Better Site Design refers to techniques to reduce the impact of site development.

Wide streets, extra parking spaces and long driveways are all features of site design that create needless impervious cover and consume natural areas. Many innovative site planning techniques, also known as Low Impact Development, have been shown to sharply reduce the impact of new development and reduce development costs. Oftentimes, however, local zoning, parking or subdivision codes needs to be adjusted to allow developers to use these techniques.

Erosion and Sediment Control – Unless proper erosion controls are used, large amounts of sediment from construction sites can wash into nearby streams. Preventing soil erosion during construction is essential for protecting streams and buffers. ***Note:*** The Red Brook Watershed Based Plan does not incorporate any recommendations in this category since existing and upcoming measures were deemed adequate. The Maine Erosion and Sediment Control Law is in effect, and all excavation contractors working in the shoreland zone will need to be certified in erosion control practices by the Maine DEP by 2013.

Stormwater Management – Stormwater is managed by conservation practices that temporarily store runoff to remove pollutants, control peak flows, protect stream channels from erosion and prevent flooding. In impacted watersheds (such as Red Brook), this technique is very important.

Non-Stormwater Discharges - In addition to stormwater runoff, there are other sources of pollution (e.g., wastewater, industrial discharges, etc.) that can contribute significant pollutant loads to watersheds. ***Note:*** Non stormwater discharges were not deemed a threat to Red Brook, and the plan does not directly address.

Watershed Stewardship – The goal of watershed stewardship is to increase public understanding and awareness, promote stewardship, and develop funding for watershed efforts. Five types of watershed stewardship programs included in this category include maintenance of Best Management Practices and pollution prevention, monitoring, restoration, and education.

7. Watershed Goals, Objectives And Restoration Targets

7.1 Goals & Objectives:

There are both long and short term goals of the Red Brook Watershed Based Management Plan. The goals are to restore the stream to its statutory classification, protect the stream for the long term, allow for a more comprehensive and orderly management of growth in the watershed and involve local stakeholders from the watershed. The following goals and objectives were established by the project steering committee and stakeholders at several public workgroup meetings:

Goal 1 **Improve the water quality of Red Brook to meet Maine water quality standards.**

Objective 1: Ensure that Red Brook meets Class C water quality standards for in-stream habitat.

Objective 2: Continue to monitor PCB levels in fish tissue until below action levels.

Goal 2 - Protect water quality and aquatic and wildlife habitat from degradation so brook continues to meet State water quality standards.

Objective 1: Develop zoning and ordinances to guide new development to protect the brook.

Objective 2: Improve the management of stormwater runoff from existing development in an effort to improve stormwater quality and reduce peak stormwater flows.

Objective 3: Develop an efficient comprehensive approach in the development review process to minimize impacts to Red Brook.

Goal 3 - Build community support for the protection and enhancement of the land and water resources of the Red Brook Watershed.

Objective 1: Develop an outreach program for citizens and businesses to promote and implement the watershed management plan.

Objective 2: Develop and establish the Red Brook Workgroup to oversee Plan implementation and work towards long term health and ensure the Watershed Based Plan goals are continually met.

7.2 Pollutant Reduction and Restoration Targets

DEP has not completed **TMDL** studies for Red Brook, and therefore specific pollutant reduction targets have not been developed. However, targets were developed as part of the watershed planning process. Preliminary results from the DEP's **Impervious Cover** TMDL, which includes Red Brook, has also been incorporated into these targets.

TMDL is an acronym for **Total Maximum Daily Load**, or the total amount of a pollutant that a water body can receive and still meet water quality standards.

- **PCB Targets**

The restoration target is to have PCB levels in Red Brook fish below the CDC action level of 11 ppb so that the consumption advisory is lifted. The long term goal levels near zero or matching those in reference streams. The DEP has not completed a TMDL study for PCBs in Red Brook so specific pollutant load reductions have not been developed. If the DEP completes this study, this information may be incorporated in future plan updates.

Decreasing Impervious Cover

Decreased impervious cover in the watershed by 3% doesn't mean we need to halt development or remove pavement but instead disconnect direct untreated flows to Red Brook. Need to disconnect treat existing runoff from ditches, parking lots, roof tops, etc.

- **Stream Habitat Restoration Targets**

The plan includes 28 stream restoration projects, which have been prioritized based on feasibility and stream benefits. Successful implementation of the projects should significantly improve stream habitat and reduce sedimentation in these degraded sections of Red Brook.

Restoration targets include six in-stream habitat projects along 6260' feet of stream channel. In addition to creating habitat, two of these projects would address 300' of severe stream bank erosion, which contributes an estimated 54 tons of sediment to the stream annually (EPA Region 5 Method). Ten stream corridor sites are also targeted for remediation. These sites are erosion problems associated with road ditching and stormwater outfalls that result in the delivery of an estimated 39 tons of sediment per year into the stream (EPA Region 5 Method).

- **Stormwater Treatment and Impervious Cover Targets**

A direct correlation has been established between impervious cover and the health of aquatic ecosystems. It has been shown that when 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 (CWF, 2003).

DEP is in the process of developing an Impervious Cover TMDL for Red Brook and several other Maine streams. According to this study, the Red Brook watershed has 16% impervious cover. DEP has found that in order to support Class C aquatic life use, the watershed should have the characteristics of a watershed with 13% impervious cover (Maine DEP Draft TMDL, 2011). This amounts to a reduction of approximately 19% of the stormwater runoff volume and associated pollutants when compared to existing pollutant loads and translates to approximately 61 acres treated. This TMDL target may guide stormwater retrofits and other projects that reduce the impact of existing impervious surfaces.

8. Red Brook Action Plan

8.1 Plan Oversight

It is important for local participants to take an interest and work together to improve water quality and stream habitat. The Red Brook Watershed Based Plan will be carried out by a Red Brook Workgroup, which will be officially formed after the plan is finalized and approved. It is envisioned that the plan will be approved by January 2012. The Town Council will form the workgroup according to typical procedures of forming committees.

The Town of Scarborough will take the lead role in the Red Brook Workgroup. Other participants serving on the workgroup may include Cumberland County Soil & Water Conservation District, Maine DEP, City of South Portland and watershed landowners. It is currently envisioned that the MDOT and MTA will be involved. The Workgroup stakeholders would meet twice a year. One of these meetings may be structured as a public meeting as a means of providing the community with updates about the brook and implementation efforts.

Additional action groups may be necessary to provide more efficient implementation of the Action Plan. All groups may require interaction with each other and collaborative participation is necessary for the successful implementation of the plan. Possible subcommittees could include: Water Quality & Protection, Stream Habitat Restoration and Education & Outreach.

Table 9. Red Brook Action Plan

Priority Ranking Key: **H = High** **M = Medium** **L = Low**	Priority	SWCD & DEP	Town	MDOT & MTA	Landowners	Me DEP	Other Grants	Town	Private	Volunteer	Federal		
Action Items		**Responsible party**				**Funding Source**						**Cost Est**	**Schedule**
Improve the water quality of Red Brook													
Improve Culverts for fish passage & stream habitat													
MDOT will address issues at 7 identified culvert sites	H			X							X	unknown	2013 and ongoing
Maine Turnpike Authority will review/consider 1 identified site	H			X					X			unknown	2014 and ongoing
Town of Scarborough to address 2 identified sites	H		X	X								$40k	Beginning 2012
Private landowners to address issues at 2 identified sites	M				X							$1,000	Beginning 2012
Landowner Outreach for private sites C9,C10, SC-7	M	X	X				X	X	X		X	$1,500	Beginning 2012
Stabilize Stream Corridor Erosion Sites													
MDOT will address issues at 5 identified sites and will collaborate with the Town on one	H		X	X							X	unknown	2011 and ongoing
Maine Turnpike Authority will address 4 identified erosion sites	H			X					X			unknown	2011 and ongoing
Private Landowner to address 1 identified site	M				X				X			$15K	2015 and ongoing
In-Stream Sites													
MDOT to address 4 identified in-stream sites that will include log and boulder additions	M	X		X		X	X	X	X		X	$70k	2015 and ongoing
MTA to address 1 identified site to include log and boulder additions and collaborate on one other site with CMP, Private landowners and MDOT	L	X	X	X	X	X	X	X	X		X	$30k	2015 and ongoing
Protect water quality; aquatic and wildlife habitat													
75' undisturbed buffer be maintained for all perennial streams and tributaries in watershed	H		X					X				$25,000	Beginning 2012
Encourage conservation of undeveloped lands within the rural and farming area of waterhsed	H		X					X				in place	n/a
Incentivize the use of development transfer programs to conserve undeveloped land	H		X					X				in place	n/a

	Priority	SWCD & DEP	Town	MDOT & MTA	Landowners	Me DEP	Other Grants	Town	Private	Volunteer	Federal		
Action Items		**Responsible party**				**Funding Source**						**Cost Est**	**Schedule**
Establish stormwater management standards specific to meet the needs of the watershed.	H		X					X				$40,000	Beginning 2013
Develop an efficient comprehensive approach in the development review process to minimize impacts to Red Brook	H	X	X					X				$20,000	Beginning 2012
Structural Retrofits													
Implement identified structural retrofits	L	X			X	X	X	X	X		X	$1.9 m	beginning 2016 and ongoing
Education, Outreach & Funding													
Promote community education, public involvment and watershed stewardship	M	X	X		X	X	X	X				$3,000	Beginning 2012 and ongoing
Involve the local high school Ecology Club to assist with Habitat Restoration and Stream Clean Ups	M											$2,000	Beginning 2012 and ongoing
Install watershed boundary signs	M	X	X	X	X							$1,000	Beginning 2012
Establish Red Brook Workgroup to oversee Plan implementation	H	X	X	X	X			X				$10,000	Beginning 2012 and ongoing
Encourage attendance at the annual RB workgroup meeting	M	X	X	X	X							$500	Beginning 2012 and ongoing
Encourage Pollution Prevention & Good Housekeeping Measures	H	X	X	X	X							$500	Beginning 2011 and ongoing
Continue to utilize and update the Red Brook Webpage and offer email notification service for updates.	M	X	X	X	X							$500	Beginning 2011 and ongoing
Monitoring Plan		X	X				X	X				$50k	
Monitor In-stream installations of best management practices	M	X	X	X	X	X	X	X	X	X		$15,000	Beginning 2015 and ongoing
Investigate whether or not hydrologic study is feasible	H	X	X			X	X	X			X	$5,000	Beginning 2012
Continue to monitor PCB levels in fish tissue until below action levels	H											$1,000	Beginning 2014 and ongoing
Water quality monitoring for macroinvertebrates and PCB's - this to be done on a five year repeating cycle as needed	M	X	X			X	X	X		X	X	$5,000	Beginning 2015 and ongoing

Phased implementation is expected to occur for many of the restoration projects identified in the plan. Many will be implemented by the Town of Scarborough, MDOT and MTA through ongoing Operations and Maintenance programs or Capital Improvement projects. The proposed ordinances relating to development will be pursued by the Town Planning Department. Outside funding, primarily in the form of grants, will be needed to support this work, funding some of the in-stream restoration projects and limited stormwater retrofits and culvert projects.

Self-supporting funding is not currently envisioned for the Red Brook Watershed although options including a stormwater utility as a funding mechanisms should be explored. If milestones and goals are not met as anticipated, through the implementation of the smaller in -stream restoration projects, stabilization of stream corridor erosion sites, alternative funding sources will be explored due to the significantly higher levels of costs to implement large structural retrofits and culvert work.

8.2 Action Plan Development

The Red Brook Action Plan includes strategies developed by watershed stakeholders at two public meetings and four subcommittee meetings. The Red Brook Workgroup may work toward implementing an action plan, which includes several actions under each of the three goals and six objectives below. The action items, responsible parties, estimated cost, schedule, cost and funding sources are outlined in Table 10 and described in the following sections.

Goal 1 - Improve the water quality of Red Brook to meet Maine water quality standards.

- Ensure that Red Brook meets Class C water quality standards for in-stream habitat.
- Continue to monitor PCB levels in fish tissue until below action levels.

Goal 2 - Protect water quality and aquatic and wildlife habitat from degradation so the brook continues to meet State water quality standards.

- Develop ordinances and strategies to guide new development to protect the brook.
- Improve the management of stormwater runoff for existing development in an effort to improve storm water quality and reduce peak stormwater flows.
- Develop an efficient comprehensive approach in the development review process to minimize impacts to Red Brook

Goal 3 - Build community support for the protection and enhancement of the land and water resources of the Red Brook Watershed.

- Develop an outreach program for citizens and businesses to promote and implement the watershed management plan.
- Develop a Red Brook Workgroup that may oversee Plan implementation and work towards long term health and ensure the Watershed Based Plan goals are continually met.

8.3 Actions to ensure that Red Brook meets Class C standards for stream habitat.

The 2010 geomorphology study provided specific in-stream restoration recommendations for

seven stream segments. The 2010 stream corridor assessment documented ten high and medium priority sites along Red Brook with floodplain and stream bank erosion associated with runoff from adjacent roads or stormwater outfalls. The stream crossing survey identified fish passage or culvert stability problems at 10 of Red Brook's 15 stream crossings. The sites identified in each of these three surveys were summarized in tables. (Appendices C-F) Note that the eight low priority stream corridor sites are not listed on the table.

A Roads and Retrofits subcommittee met on 12/9/10 and 2/3/11 to review and further prioritize restoration sites. Several sites that were identified have already been addressed by the Maine DOT, and two additional are scheduled to be addressed in the upcoming 2011/12 construction season. The Maine Turnpike Authority may also complete some of the recommended work that is considered regular routine maintenance operations, but MTA does not have immediate plans to incorporate other larger problems identified in this Plan at this time. However, MTA anticipates participating in the Red Brook Workgroup to continue on-going dialogue within the Red Brook Watershed.

Description of category recommendations include:

⇒ **Conduct in-stream habitat restoration** and utilize the large amount of standing trees, to the maximum extent practicable, to create in-stream woody debris structures.
⇒ **Mitigate identified culverts -** Stabilize and repair identified sites that relate directly to culvert impacts on the brook.
⇒ **Stabilize Stream Corridor Erosion Sites** - are identified sites with minor to major surface erosion. These sites should be stabilized and contributing runoff should also spread into adjacent buffers with level spreaders or floodplain wood to reduce impervious cover and treat stormwater.

8.4 Monitor PCB levels in fish tissue until below actions levels.

Continue to monitor PCB levels in fish tissue until below actions levels of 11 ppb and fish consumption advisory is lifted. The long term goal would be to see levels near zero or matching those in reference streams. The DEP has not completed a TMDL study for PCB's in Red Brook so specific pollutant load reductions have not been developed. If this study is conducted, information could be incorporated into future plan updates.

8.5 Develop ordinances to guide new development to protect the brook.

A Land Use Subcommittee met on 9/22/10 and 10/28/10 to provide input for the development or enhancement of existing ordinances that aim to protect and preserve Red Brook. The Town has existing incentive programs in place and will continue to encourage these options in addition to the ones listed:

⇒ **Protect the seventy-five foot (75') buffer on first order perennial and other important feeder streams within the watershed.** Currently the Town's Shoreland Zoning requires a 75' buffer to all second order perennial streams (a stream below the confluence of two perennial streams). As a means to maintain and improve water quality in this watershed, as well as provide flood control functions, wildlife habitat in and along the streams, and

maintain stream shading, this watershed plan recommends a 75' buffer be maintained on first order perennial and other important feeder streams in the watershed. Buffers have been proven effective at protecting valuable wildlife habitat and preventing a wide range of pollutants from reaching the stream.

⇒ **Encourage the conservation of undeveloped land within the rural and farming area of the watershed.** The Town, in conjunction with local conservation organizations, should prioritize the rural section of the watershed for land conservation efforts. Efforts should include working with willing sellers of land for conservation or the sale of conservation restrictions in order to keep land either natural and undisturbed or in the case of farms, keep the agricultural uses in operation with adequate buffers to the tributaries.

⇒ **Encourage the use of the development transfer program to conserve undeveloped land within the watershed through density bonuses or other incentives.** Currently the Town has a zoning tool that allows the transfer of the development that can occur in the rural, limited growth areas of Town to the designated growth areas. This mechanism should be encouraged in this watershed by including incentives to property owners, such as a density bonus to the rural property owner.

⇒ **Establish stormwater management standards specific to the needs of the watershed.** Currently the Town relies on the Department of Environmental Protection's Chapter 500 standards as well as local engineering review to regulate stormwater management for new development. Chapter 500 contains stormwater standards that apply Statewide, while this watershed could benefit from stormwater management standards that are customized to the needs of the watershed. Such stormwater regulations could be crafted in partnership with DEP to achieve the goals of Chapter 500 and this watershed plan, and could be administered locally to streamline development design, review and permitting.

⇒ **Encourage, and in some cases require, low impact development and stormwater methods.** In conjunction with stormwater standards customized for this watershed, the Town and Maine DEP should promote the design and use of low impact development techniques that are consistent with the zoning and land use standards in the watershed. In particularly sensitive areas within the watershed, consideration should be given to requiring such low impact development methods.

⇒ **Anticipate and prevent impacts of future stream crossings and stormwater outfalls**. Ensure that new stream crossings incorporate culverts that span the bank full width of the channel and/or utilize floodplain culverts. Stormwater retention basins should outfall onto the floodplain at several points and wood placed on the floodplain to further prevent incision by stormwater flows. (As recommended by Field's Geomorphology report)

8.6 Improve the management of stormwater runoff for existing development in an effort to improve storm water quality and reduce peak flows.

⇒ **Encourage the implementation of stormwater management improvements and retrofits through incentives for re-development.** As mentioned previously, there are existing private developed sites that would benefit from stormwater management upgrades or

retrofits. Such enhancements would help Red Brook by removing pollutants and peak flows. There is a good opportunity to incorporate such improvements when redevelopment or expansion of these sites is planned. The Town, in conjunction with the Maine DEP, should explore zoning and land use incentives to encourage redevelopment projects to improve existing stormwater facilities that don't meet current standards or impact the stream.

⇒ **Encourage increased buffers to Red Brook and its tributaries through incentives for redevelopment.** In some locations, existing development and impervious area encroaches on Red Brook and its tributaries. In these locations the brook, and the watershed in general, would benefit from additional vegetated strips of land next to the brook. There is a good opportunity to incorporate such improvements when redevelopment of these sites is planned. The Town should explore zoning and land use incentives and flexibilities to enable additional vegetated strips of land and setbacks to be established as part of redevelopment projects.

⇒ **Ensure pollution prevention and good housekeeping tools are utilized to minimize polluted stormwater runoff from impervious surfaces.** The following tools provide both general guidance and specific programmatic recommendations for public and private good housekeeping and pollution prevention efforts. Towns and MDOT and MTA and many businesses already employ good housekeeping practices that help prevent pollutants from reaching Red Brook.

- **Street Sweeping**—All streets within the Town on an annual or biannual basis. Higher priority should be given to the streets surrounding Red Brook because of its urban impaired status.
- **Catch Basin Cleaning**—Catch basin cleaning should occur at least twice per year and on an as needed basis.
- **Ditching Maintenance**—Should be conducted on a regular basis including excavation of sediment, vegetation removal, and sediment and erosion control of these ditches.

⇒ **Implement stormwater retrofits on large impervious properties connected to Red Brook.**

In 2010 field assessments, five retrofit locations were identified within the priority developed areas of the Red Brook Watershed. Appendix 4 contains the list of structural retrofit opportunities, a table of locations and Appendix 5 contains the location of retrofits within these sites. Designs provided in Appendix 5 provide treatment and storage for approximately 17 acres of impervious area. As resources become available, it is recommended that the retrofit designs be broken down into manageable pieces. Small retrofits in many locations may be beneficial for temperature and reduced runoff volumes.

The total cost for implementation of these best potential retrofits would be approximately 1.9 million dollars or approximately $112,000 per impervious acre managed. In this evaluation, cost estimates for each retrofit site were evaluated independently, and actual

implementation costs are likely to be less than estimated based on mobilization, engineering and survey "economies of scale" if more than one retrofit is implemented at one time. In most cases, it is unlikely that an individual retrofit site (particularly small retrofits) would be designed and constructed independently and therefore the cost per unit of impervious acre is likely to be less than indicated above. These estimates do not include drainage easement costs, survey costs and contingencies and what type of retrofits may actually be used. Regardless, $112,000 per impervious acre is likely to be a high estimate but it is a conservative planning level evaluation.

8.7 Develop an outreach program for citizens and businesses to promote and implement the watershed management plan.

Promoting community education, public involvement and watershed stewardship may directly benefit the Red Brook Watershed Management Plan by:

- Showing property owners and managers how their individual behaviors and actions can collectively promote and maintain 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 management into the built environment. This strategy may increase awareness of watershed health issues and the acceptance of the innovative and effective stormwater management practices identified here in the Red Brook Watershed Management Plan.

⇒ **Involve volunteers in habitat restoration projects.** There are several reaches of Red Brook that are candidates for in-stream habitat restoration. The Working Group should involve local ecology clubs and volunteers to conduct restoration projects. Scarborough High School has an Ecology Club as well as a Key Club that are always looking for service projects. Reaching out to the local schools, as well as allowing the students to participate in a volunteer program may not only accomplish the goals within the Red Brook Watershed Management Plan, it may lead to a greater understanding of the impaired stream issue throughout the community.

⇒ **Install signs at stream road crossings.** There are four stream crossings within the Town of Scarborough where Red Brook flows under the roads. Stream crossing signs could be installed in these locations to raise awareness with residents and passersby about the location of Red Brook. Keeping the waterbody in the forefront of people's thoughts may prevent illicit discharges in the area, as well as promote awareness of the watershed.

⇒ **Organize stream cleanups.** A stream clean up day can be proposed for

the lowest reaches of Red Brook. These lower reaches are more accessible and have accumulated trash that can be collected by a group of volunteers. Cleanups could be organized in partnership with adjacent businesses in the Payne Road area.

⇒ **Continue to update the Red Brook project website.** The website may report on restoration projects as well as the other tasks outlined in the Red Brook Watershed Management Plan. A list serve may also be developed to provide more frequent updates. The intent is to have the Webpage transferred to the Towns website in order to make it simpler to do updates and follow up of specific items.

⇒ **Look for opportunities to treat and store road runoff from roads in the watershed.** A significant amount of impervious area is associated with the 22.4 miles of roads in the Red Brook watershed. Many of the site-specific impacts of these roads have been identified and included in other sections of this action plan. In addition to these projects, MTA, DOT and municipalities should also look for opportunities to treat and store road runoff from other sections of road. These road retrofits and BMPs (e.g., level spreaders into buffers) could disconnect impervious areas from the stream and be much more cost-effective than some of the retrofits mentioned in the previous section.

8.8 Develop a Red Brook Workgroup that may oversee Plan implementation and work towards long term health and ensure the Watershed Based Plan goals are continually met.

⇒ **Convene the Red Brook Work Group making sure that all watershed stakeholders are represented.**

⇒ **Conduct at least two meetings per year to oversee and guide plan implementation.** Promote one of the meetings with the public and share information about the progress made in restoration efforts .

⇒ **Apply for grants and other funding to implement plan.** See Funding section for more information about funding strategy.

9. Monitoring Plan

Ongoing monitoring is be needed to determine whether the plan's environmental goals are being met and/or if progress is being made towards these goals. Different approaches may be needed to monitor progress associated with each of the goals.

9.1 Adjust Watershed Boundaries

Most of the RB watershed boundary has been ground-truthed - especially in the developed

areas with stormwater infrastructure, developed lots and roads. Based on the experiences in neighboring Long Creek, these boundaries may shift over time as properties are modified or as even slight grade changes are made to ditches and parking lots. The boundary that was created by the Town of Scarborough is the best available representation, and should be used for the maps in this plan.

There are a few relatively small areas that were not ground-truthed. These include:

- NW edge of watershed along Saco Street – Last fall, a resident pointed out a culvert under Saco Street that would pull in some land on the west side of Saco Street adjacent to the Wassamki Springs Campground. MDEP Field technicians also saw this culvert but there was some question about whether or not to pull in the Wassamki Springs pond into the watershed. No clear outlet was seen or found and as a result the pond could be considered a kettle hole.

- Wooded, Flat Area North of Smiling Hill Farm – The boundary above Smiling Hill Farm was not ground-truthed since it is covered with woods and wetlands. MDEP reviewed the contour lines, and determined it could be difficult to ground-truth unless the town gets two foot contour lines in this area.

- Shared Long Creek/Red Brook Boundary above Running Hill Road – This area was not ground-truthed during the Long Creek process since it was not critical to their work. MDEP didn't venture into the area either since it would have taken quite a bit more time than was available.

The plan intends to field check and map the boundaries in the future as resources allow, as new information is provided to us by the Town of the Long Creek Watershed Management District, or as needs arise where this information is required. Due to the uncertainty in these areas and the inherent incremental changes in watershed boundaries over time, Red Brook maps should indicate that the boundary is the 'best representation available' and future town ordinances proposed by the plan should not be tied to watershed maps (similar to Shoreland Zoning) but to actual site drainage conditions.

9.2 Water Quality Protection

DEP's macroinvertebrate monitoring (or biomonitoring) will be the primary means used to assess whether Red Brook's water quality continues to meet or exceed Class C standards. Benthic macroinvertebrates are useful indicators of the effects of a wide range of stresses on streams and are also used to determine whether Maine streams meet their aquatic life criteria. DEP's past macroinvertebrate monitoring indicates that all stations on Red Brook meet or exceed Class C standards, and future monitoring can reveal changes in stream quality. It is anticipated that DEP may continue to monitor these stations every five years as part of

their ongoing sampling program. If biomonitoring data or other information indicates potential problems or declining water quality, the Red Brook Workgroup may work with Maine DEP to evaluate options for more targeted water quality monitoring.

9.3 PCB Decline in Fish Tissue

DEP has analyzed fish tissue in Red Brook fish three times over the past nine years. This periodic monitoring should continue until PCB levels fall below the CDC action level of 11 ppb. Since it can take many years for PCBs to work out of stream systems, periodic monitoring can also help show declining trends or progress toward this goal.

Testing could be repeated annually. However, given the cost of the laboratory analysis ($1,500 in 2009) and the lag time often needed for PCB levels to decline, a 3-5 year monitoring frequency might be more realistic. DEP staff and funding may continue to be available to help with periodic monitoring. However, given DEP's limited resources, the Town of Scarborough may probably also need to contribute toward laboratory costs.

9.4 Stream Habitat Restoration

The final environmental quality goal of the plan is for Red Brook's stream habitat to be improved so that it meets Class C standards. Monitoring is recommended for all in-stream restoration projects to make sure the projects are functioning as designed. Large wood placed in the stream should be regularly inspected to make sure it is stable and providing habitat benefits as planned. Photo points may be established at each restoration site. Upstream and downstream photos may be taken at each point before construction, immediately after construction and then annually to document effects on Red Brook. DEP staff may be updated about habitat restoration projects, and consulted about how and when to conduct a follow up stream habitat assessment to determine if the stream is progressing toward or meeting stream habitat criteria.

10. Measures of Success

Red Brook does not currently meet State water quality standards due to habitat impairment and PCB levels in fish tissue analysis. The goal of this plan is for Red Brook to meet State water quality standards by 2021.
It is proposed that this goal be accomplished by implementing nonstructural measures to limit the impact of all impervious cover and implementing in-stream, riparian and floodplain restoration projects and by reducing direct discharge to the stream by installing structural retrofits.

Since it may take ten years for Red Brook to meet State water quality standards, interim milestones may also be tracked to measure progress on Plan implementation. Interim and long term measurable milestones include:

10.1 Organizational Milestones

- Establishment and formation of Red Brook Workgroup
- Bi-annual meetings of the Red Brook Workgroup
- Annual Town Council update
- Web Page updates
- Email listserve developed for watershed stakeholders
- Amount of funding secured

10.2 Environmental & Structural Milestones

- Number of impervious acres treated with stormwater retrofits
- Number of stream channel structures installed (i.e., wood, logs, boulder additions)
- Number of sediment load reduction associated with identified corridor sites
- Number of stream corridor sites addressed
- Number of fish passage barriers addressed
- Number of culvert issues addressed

10.3 Water Quality Milestones

- Declining PCB levels in fish tissue analysis
- Stream habitat restoration projects determined to be stable and functioning
- Continues to meet Class C standards for macroinvertebrate
- Removed from 303 d list for Stream Habitat Impairment and PCB's

10.4 Adaptive Management Approach

Adaptive management is the process by which new information about the health of the watershed is incorporated in the watershed management plan. An adaptive management approach is widely recommended for restoring urban watersheds (CWP, NSF paper). Adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short-time frame. As new data/information and or technology become available, this approach establishes a mechanism for restoration efforts that can be adjusted to meet the current needs of the watershed over time.

11. Funding Opportunities

11.1 Funding Approach

Many of the restoration projects identified in the plan will be implemented by the Town of Scarborough, MDOT and MTA through ongoing Operations and Maintenance programs or Capital Improvement projects. It is anticipated that the ordinances proposed for development in the plan will be pursued by the Town Planning Department independently although outside contractors and grants may provide information and move the process forward. Outside funding, primarily in the form of grants, will be needed to support this work,

fund some of the in-stream restoration projects and limited stormwater retrofits and culvert projects. Self supporting funding is not currently envisioned although a stormwater utility or other funding mechanisms will be explored if milestones and goals are not met as anticipated due to the large structural retrofits and culvert work would require significantly higher levels of funding.

11.2 Grant Funding

Various grants are available at the local, state and federal level to help implement the Red Brook Watershed Based Management Plan. Often grant funding is useful for non-structural programs, for project enhancements, or for projects that would not be constructed unless grant funds are available. Since grant funding is an inconsistent source of financing, it should not be considered as the primary financing mechanism for the implementation of the Watershed Management Plan.

Funding Source: Maine DOT Transportation Enhancement Program

(www.maine.gov/mdot/community-programs/enhancement-program.php)
Description: Municipal candidates are eligible. Eligible categories include bicycle/pedestrian, scenic/landscape/historic, and Environmental. The best probable opportunity for Red Brook WMP would be an environmental grant (soil erosion, detention and sediment basins, river clean-ups, etc.)

- Highly competitive
- Applications due July 1 (see website for more details)
- State Roadway retrofits

Funding Source: Maine DOT Community Investment Sharing

Description: Financial assistance for implementation of streetscape amenities to highway improvement projects in urban and village settings.

- Competitive cost sharing with communities
- State Roadway retrofits, Town Roadway Retrofits

Funding Source: Nonpoint Source Grants Programs 2013 (319 grants)

Description: Maine DEP grants—The primary objective of NPS projects is to prevent or reduce nonpoint source pollutant loadings entering water resources so that beneficial uses of the water resources are maintained or restored. Maine public organizations such as state agencies, soil and water conservation districts, regional planning agencies, watershed districts, municipalities, and nonprofit (501(c)(3)) organizations are eligible to receive NPS grants.

- Annual grant RFP issues in April with project commencing following April
- Town Roadway retrofits, Private facility retrofits, stream enhancement-buffers, regional facilities.

Funding Source: Five-Star Restoration Matching Grants Program

(www.epa.gov/owow/wetlands/restore/5star/)
Description: Open to any public or private entity engaging in community-based restoration.

Projects must include a strong on-the-ground wetland, riparian or coastal habitat component and must also include a strong training, education, community stewardship and/or outreach component. Projects must involve diverse partnerships that contributes funding, technical assistance, workforce support and in-kind services.

- Competitive—grants up to $500,000
- Applications due in March and June
- Projects must be complete in one year
- Stream Enhancement Buffers
- Yardscaping Outreach Program

Funding Source: Casco Bay Estuary Partnership Habitat Restoration Grants
http://www.cascobay.usm.maine.edu/
Description: Open to non-profit conservation groups (landtrusts, watershed groups), towns, state and federal conservation agencies. Project criteria includes land protections, acquisition of high value habitat, public access, level of threat, size of project, cost effectiveness, community support, matching funds and likelihood of implementation. Applications are processed when received with no deadlines. Submit electronic copies of proposal, budget and letters of support.

- Grant range from $1000—$20,000 but larger amounts are considered
- In-stream habitat restoration projects, buffer enhancements

11.3 Private Foundation Funding

Funding source: Davis Conservation Foundation
(www.davisfoundations.org)
Description: Only open to organizations that are tax exempt under Section 501 © (3) of the IRS code. The Foundation supports organizations whose primary interested are related to wildlife, wildlife habitat, environmental protection or outdoor recreation. Projects that strengthen volunteer activity and outreach/community involvement are of particular interest.

- Grants range from $2,000 to $100,000
- Bi-annual submissions deadlines are April 10 and October 10
- Funding possible for monitoring Program, Yardscaping, Outreach Programs, Town Roadway retrofits, stream enhancement-buffers.

Funding Source: John Sage Foundation
(www.megrants.org/sageindex.HTM)
Description: Only open to organizations that are tax exempt under Section 501 © (3) of the IRS code. Types of projects that have been funded include land acquisition and site evaluations, water testing programs, environmental education, and community garden programs.

- Grants range from $500 to $2500
- Bi-annual submission deadlines are February 15 and August 15.

Funding Source: Henry P. Kendall Foundation

(www.kendal.org/grants/types.html)

Description: Open to non-profit organizations classified as public charities under Section Section 501 © (3) of the IRS code. Funds are provided for general operating needs and for specific programs and initiatives. Examples of previous projects funded include: Advocacy, public education, policy research and analysis, on-the-ground resource management experiments and institutional development.

- Grants range from $20,000 to $50,000
- Bi-annual submission deadlines in June and December

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Water Quality Assessments
Appendix A

Dissolved Oxygen

Dissolved oxygen (D.O.) is the amount of oxygen in the water. Almost all organisms, including those living in the water, need oxygen to survive. Oxygen levels that are too low severely reduce the diversity and population of aquatic communities. As such, the amount of D.O. in the water is very important to stream life, and it is one of Maine's water quality criteria for streams and rivers.

During the 2002 study, DEP collected 10 dissolved oxygen samples from three stations on Red Brook (Stations 1, 3 and 10). All 10 samples exceeded Class B standards for both dissolved oxygen concentration and percent saturation. As part of the watershed plan project, monitoring equipment (called data sondes) was placed in three locations in Red Brook from June to November 2010. The data sondes collected over 13,000 measurements of dissolved oxygen (percent saturation and concentration) at 15-minute intervals. This continuous data provides much more information about dissolved oxygen conditions over a long time period.

Project consultants collected water quality data at 3 datasondes stations

Overall, the data showed high levels of dissolved oxygen at all three sites. All measurements exceeded the stream's required Class C limits. The lowest measured values were near 7 mg/L, which is the limit for Class B stream in Maine. Of the three sites, the Site 3 (just below Payne Road) had the lowest dissolved oxygen values. The DO minimum at this site was 6.6 mg/L with 393 readings below 7 mg/L. Dissolved oxygen measurements at this station also recorded the highest temperatures.

Specific Conductivity

Specific conductivity is a measure of the dissolved ions in the water column. Although the measure does not identify specific ions present (i.e., if the ions are nutrients, metals or other pollutants), it can indicate the amount of pollutants in a waterbody.

The 2002 DEP Study measured specific conductivity in 10 samples on four different dates and three sites (Sites 1, 3 and 10). Specific conductivity for all samples was below 400 uS/cm. As part of the watershed management plan project, datasondes also measured specific conductivity continuously (15 minute intervals) at Sites 2, 3 and 5 between June and November 2010.

The average specific conductivity was similar to the findings of the 2002 study, with long-term averages for each site near or below 400 uS/cm. However, there were clear differences between each location. Sites 2 and 3 experienced much higher specific conductivity readings

with highs at 718 and 812 uS/cm, respectively. The values were much more variable in these sites as well. In contrast, the readings for Site 5, which is located in a relatively undeveloped part of the watershed, remained relatively constant and quite low. Nonpoint source pollution from the developed areas near Sites 2 and 3 is likely responsible for the elevated values and high variability of specific conductivity.

Metals

Streams located in urbanized watershed often have elevated levels of heavy metals in the water column and sediments. Industrial sources and automobiles are major contributors. Chronic exposure to heavy metals can result in the loss of sensitive species and lower overall abundance and diversity. DEP's 2002 Study analyzed samples for metals (nickel, lead, cadmium, copper, zinc and mercury) at Stations 1, 3, and 10 (once during low flow conditions and three times during storm flows). When metals were detected in the samples, they were all well below the water quality criteria (DEP, 2002).

> Note: Mercury was detected once during the study at the site above Running Hill Road. Although the elevated value could have been from atmospheric deposition or the nearby landfill, it was attributed to a field error since the study did not use the rigorous techniques now required for mercury sampling.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a large class of organic compounds that are used in industrial operations and found in gasoline. Although aquatic life criteria have not been established for PAHs, they are considered to be harmful to aquatic life and human. The DEP (2002) study collected two storm samples above Payne Road and did not find PAHs in either sample.

E. coli bacteria

Maine standards for E. coli state that the number of *E. coli* of human origin may not exceed a geometric mean of 126 per 100 ml or an instantaneous level of 236 per 100 for Class C waters. DEP measured *E. coli* bacteria in nine water samples collected from Stations 1, 3 and 10 on Red Brook (6 samples during baseflow and 3 samples during stormflow). Most of the samples (8 of 9) had very low levels of E. coli present. However, *E. coli* bacteria were fairly abundant in water samples collected from Station 1 during storm flows (10/18/00). The DEP study did not differentiate between human and non-human *E. coli*. However, this one sample would have the potential to violate Class C instantaneous conditions if the *E. coli* were of human origin.

Oil and Grease

The DEP study (2002) collected nine water samples and analyzed them for oil and grease concentrations. There were six storm samples and three base flow conditions from Sites 1, 3 and 10. Seven of the nine samples had oil and greater concentrations below the "practical quantitation" level of 5.0 mg/L. However, two samples and one storm at Site 3 had detectable values of 8.2 and 7.5 mg/L.

Nutrients

Nutrient pollution, particularly phosphorus and nitrogen, is one of the most common pollution problems. Sources of nutrients include soil erosion, road sanding, fertilizer use, illicit discharges and leaking sewers. DEP's 2002 study analyzed samples for nutrients at Stations 1, 3 and 10 (once during low flow conditions and three times during storm flows). Nutrient levels were relatively low. DEP did not observe macrophyte/periphyton growth in the stream in both the 2002 study and 2010 field surveys, which also indicates that nutrients are not a significant problem for the stream.

Water Temperature

Urbanization often results in increased stream temperatures. This increase can be caused when stream side trees are cleared and stream shading is reduced and runoff from heated paved surfaces and man-made ponds (such as stormwater detention ponds) washes into streams. Temperatures greater than 21°C have been found to severely stress brook trout and most other coldwater organisms (Galli 1991).

Continuous temperature loggers were installed at Stations 1, 3 and 10 on Red Brook for most of the summers in 1999 and 2000. All sites had relatively low temperatures with maximum weekly temperatures often <22°C and always < 24°C. Average weekly temperatures were always <21°C (DEP 2002). The continuous temperature monitoring at Sites 2, 3 and 5 in 2010 showed similar results, although Site 3 (below Payne Road) stood out as the warmest site with a maximum of 25.1°.

Since most of Red Brook's riparian buffer is intact, stream shading helps keep stream temperatures low. Site 3, below Payne Road had much higher stream temperatures than the upstream station, probably due to warming of stormwater on pavement and in stormwater ponds.

Appendix B

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

1. An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBMP (and to achieve any other watershed goals identified in the WBMP), as discussed in item (2) immediately below and is located in Sections 6.

2. An **estimate of the load reductions expected** for the management measures described under (3) below is described in Section 7.

3. A **description of the NPS management measures** that will need to be implemented to achieve the load reductions estimated under (2) above (as well as to achieve other watershed goals identified in this WBMP), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan are located in Section 6 and Section 8, respectively.

4. An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan is described in Table 10, Section 11.

5. An **information/education component** that will be used to enhance public understanding of the project is located in Section 8.7.

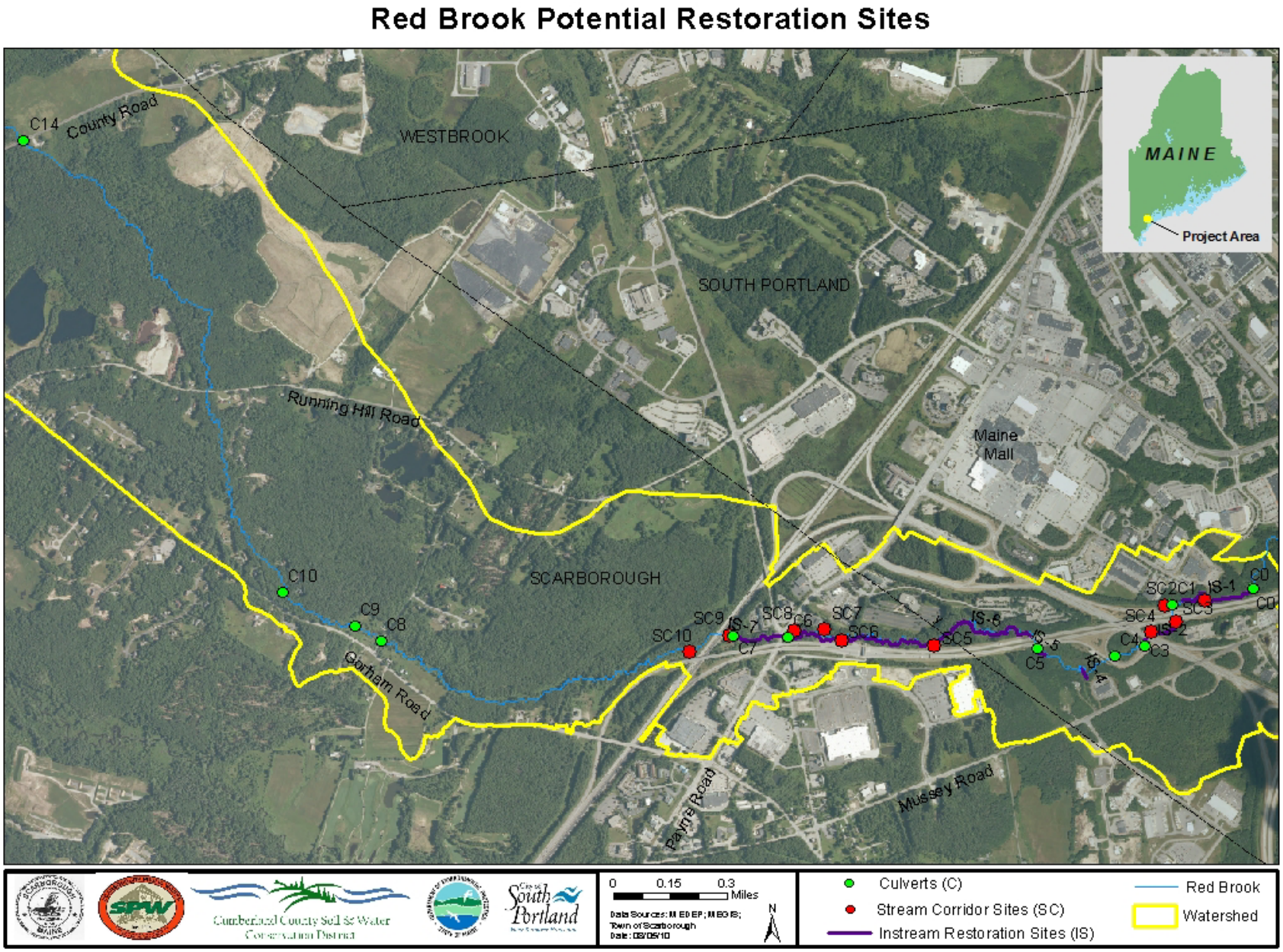
6. A **schedule for implementing the NPS management measures** identified in this plan is in Section 8 and Table 10.

7. A **description of interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented can be found in Section 10.

8. A **set of criteria** that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards water quality standards; and if not, the criteria for determining whether this WBMP needs to be revised is in Section 10.

9. A **monitoring component** to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (8) above is can be found in Section 9.

Figure 11. Red Brook Potential Restoration Sites



Appendix C. In-Stream Identified sites & Restoration Opportunities

Site	Reach Identification/ Location	Owner	Description	Recommendations	Est. Cost	Tier Level	Feasi-bility	Benefit	Ranking Priority
In-Stream Sites									
IS-1	Reach B	MDOT	Second perched drainage pipe further downstream of the large culvert - severe bank erosion - drainage pipe is draining parking lot	Severely eroding banks downstream - construct crib log crib wall consisting of installing line of vertical log piles. Consider the transfer of energy further downstream and plan for this by adding boulders and anchor logs.	$25k	1	H	H	6
IS-2	Reach C (btwn MTA approach road & I-295 at downstream)	MDOT	Double box culvert - natural high bank confinement. At downstream end less confined left bank, smaller flood plain with large sand and gravel bar 50 ft upstream.	Increase channel complexity with wood and boulders - could employ chop & drop method	15K	1	H	H	6
IS-3	Reach D (short reach less than 100 ft long)	MDOT	Concrete constrictors at the exit of Culvert D - creates jetted flow in the reach. Entire reach under control of culverts at either end	Restoration efforts include wood and boulder structure to increase complexity. Structures need to firmly anchored due to strong flows. Consider chop and drop method	15K	3	L	L	2
IS-4	Reach F - Culvert 4	Private	Possible straightening of tributary draining nearby homes and Mussey Rd may be increasing discharge onto floodplain where scouring is occurring.	Could add log additions on the downstream end to reduce incision of the floodplain - consider chop and drop method	15K	1	M	M	4
IS-5	Reach F -mid reach	MDOT	A deep scour pool and scalloped eroding banks along the margins are immediately downstream of culvert F at the upstream end of the reach.	Could add log additions on the downstream end to reduce incision of the floodplain - consider chop & drop method	15K	3	L	H	4
IS-6	Reach G (longest reach-where fence is standing in middle of stream)	MDOT, CMP, MTA, private	Sand from deicing, resulted in large sand bars and accelerated bank erosion. A power line crosses the channel & floodplain in the middle of the reach.	Restoration for this reach would entail wood additions along much of the reach to encourage deposition and greater overbank flow. Consider employing chop & drop method	15K	1	H	H	6
				Sandbar excavation or removal	15K	3	L	L	2
				Removal of cobble	15K	2	M	L	3

	Reach Identification/ Location	Landowner	Description	Recommendations	Est. Cost	Tier Level	Feasi-bility	Benefit	Ranking Priority
IS-7	Reach H (closer to Southborough)	MTA, Pri-vate	Large silt bar developed due to constrictive effects of Cul-vert G. At two locations, stormwater discharges from retention basins are creating incision across floodplain. Upper half of reach constrict-ed due to high banks. Long linear slumps are occurring due to scour and undercutting at toe of bank.	Restoration should focus on the slumping of the high banks downstream of culvert H. Move high banks 10-15 ft back on either side to create a floodplain. Justifiable due to high bank composition of artificial fill. Provide ex-panded aprons or multiple outfalls.	Unkn	3	L	H	4
				Additionally wood on the floodplain near outfalls would baffle flows and reduce inci-sion.		1	L	M	3

Benefit Ranking Key:

High = Most beneficial to stream geomorphology and macroinvertebrate.

Medium = Some benefits to the stream geomorphology if item is addressed.

Low = Little to no benefit to the stream geomorphology.

Ranking Priority Key

High - 3
Medium - 2
Low - 1

Each column is added across for a total possible of 6. 6 being highest priority and 1 being lowest priority.

Appendix D. Stream Corridor Identified Sites & Restoration Opportunities

	Reach Identification/Location	Owner	Description	Recommendations	Cost Est.	Tier Level	Feasi-bility	Benefit	Ranking Priority
Stream Corridor Sites									
SC-1	Site #3-Across from John Rob-erts outfalls	MDOT	18" culvert from i_295 flows into a half culvert sluiceway that falls onto bare soil and into Red Brook	Problem addressed and fixed by MDOT in fall of 2010	?	1	H	H	6
SC-2	Site #7 - I-295 Ditch	MDOT	Large amount of sediment on floodplain and instream due to severe gullies from ditch runoff	Problem addressed and fixed by MDOT in fall of 2011	?	1	H	M	5
SC-3	Site #9-295 ditching behind Pape Truck	MDOT	15 meter long gully in ditch from 295 at upstream end of culvert - delta in stream	Site 9 may be corrected when we do the I-295 NB pavement preservation project in 2011-12	?	1	H	H	6
SC-4	Site #13 ditching at culvert outlet	MDOT	Ditching from 295 at outlet of culvert. Sediment delta in stream	More information needed	?	1	H	H	6
SC-5	Site #19 - Behind Turnpike toll plaza	MTA	Gully from toll plaza ditching	More information needed	?	1	H	H	6
SC-6	Site #23-Turnpike ROW Exit 44	MTA	30" culvert with downcut erodedchannel 15 meters long directly into Red Brook	Plunge Pool and rip rap needed - any maintenance may be done	?	1	H	H	6
				Plunge Pool	?	2	L	M	3
SC-7	Site #25-Lazboy detention pond	LayZBoy	Detention pond pipe 18" outlet and riprap overflow area combine into erod-ed channel that reaches stream.	Addition of logs & downed trees to floodplain to create roughness-conduct	15K	1	H	H	6
				Need armored plunge pool	8K	2	L	H	4
SC-8	Site #26 - Town of Scarborough ROW	MDOT/ TOWN	18" and 24" pipes from Paine Road. Eroded banks and lots of sediment in channel.	Town may address	?	1	H	H	6
SC-9	Site #32 - Turnpike stream crossing	MTA	Ditch erosion down to stream	More information needed	?	1	H	H	6
SC-10	Site #37 - Turnpike Exit 44 on-ramp and bridge	MTA	Gully and head cutting down to RB with sediment delta in stream	More information needed	?	1	H	H	6

Appendix E. Identified Culvert Rehabilitation Opportunities

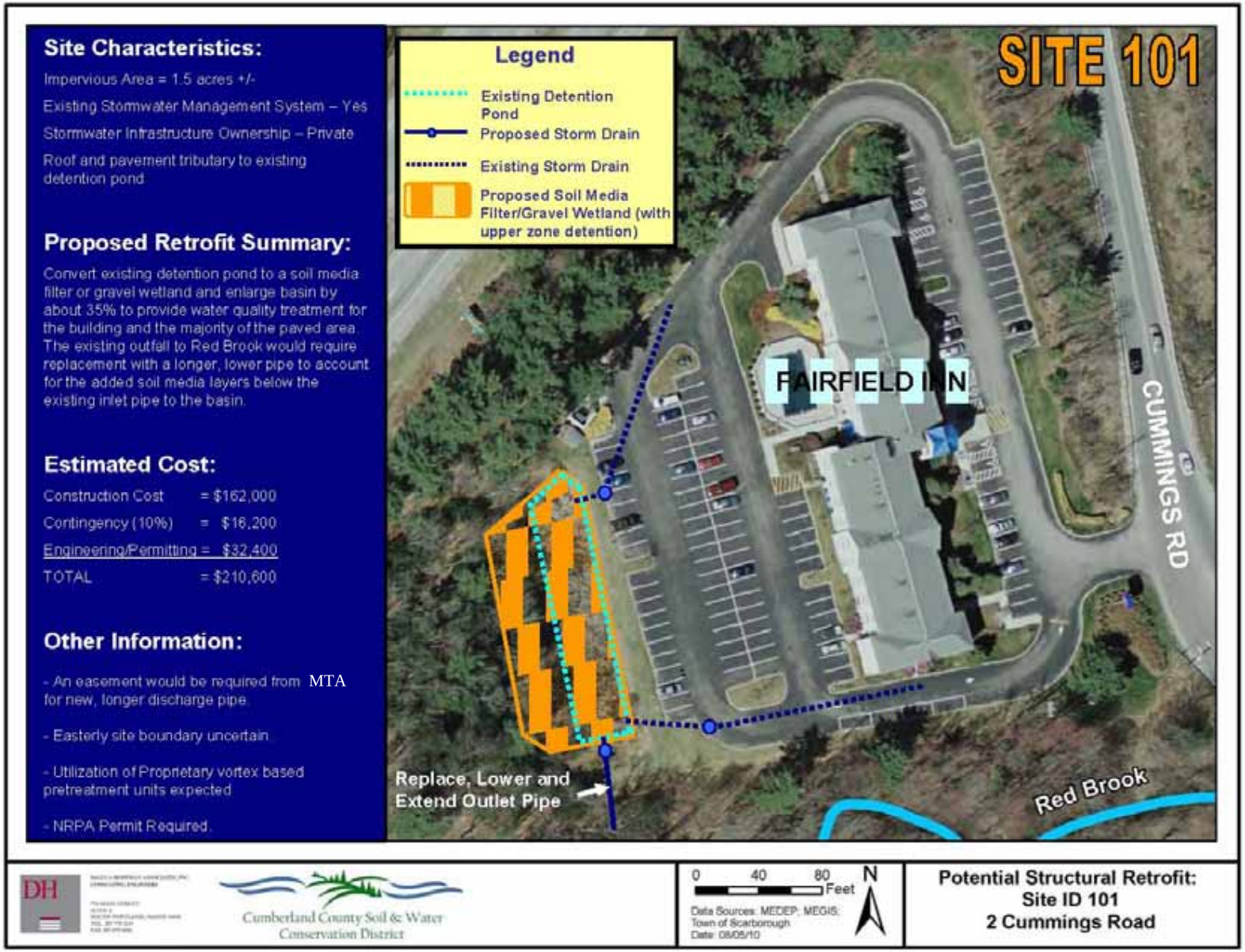
	Reach Identification/ Location	Owner	Description	Recommendations	Cost Est.	Tier Level	Feasi-bility	Benefit	Ranking Priority
Culverts									
C0	Reach A (close to Clarks Pond)	MDOT	Double culvert passes under old road. Deep scour pool and eroding banks immediately downstream of culvert-constricted channel	Remove culvert at upstream end under unused road, restoring full floodplain function would eliminate downstream scour.	$500k+	3	L	M	3
C1	Reach B -Culvert under I-295	MDOT	Culvert causing scour pool and eroded banks, constricted channel, slightly perched.	***Scour pool & bank erosion downstream of Culvert B*** *-resizing Culvert B or adding floodplain culverts adjacent to existing culvert. If culvert replacement not feasible - then addition of logs in the pool, boulder weir at outlet. If funded, MDOT may correct in next biennial work plan as culvert rehabilitation project (recommendations include conducting a Hydrological study)*	?	3	H	H	6
C4	Reach F - I-295 Spur Exit	MDOT	Deep scour pool and scalloped eroding banks, channel takes right angle,	Weir plates in hand, waiting for opportunity to do the installation	?	1	H	H	6
				re-size culvert, removal of cobble and installation of floodplain culverts	?	3	L	M	3
C5	Reach G (longest reach -where fence is standing in middle of stream)	MDOT	Has a relatively wide floodplain (alder thicket) channel mostly unaffected by culverts at either end. Fish passage issue/rocks at culvert outlet could create fish barrier	Installation of floodplain culvert under I-295 at the downstream side. Removal of cobble riprap may allow natural channel adjustments to occur without threatening any infrastructure.	?	3	L	H	4
C3	295 Spur Exit	MDOT	undersized culvert	Weir plates are in hand, may install at first low flow opportunity	?	1	H	H	6
				add floodplain culverts or replace existing	?	3	L	M	4
C6	Paine Road crossing	Town/ MDOT	fish passage issues	Ryan may check to see if this location has a bridge #	?	1	H	H	6
C7	Turnpike behind Fairfield Inn	MTA	fish passage issues-rocks at culvert outlet could create fish barrier, eroding ditches contributing sediment as well	MTA to do any routine maintenance necessary but costly and more involved retrofits are not being considered at this time	Unk	2	L	H	4

	Reach Identification/ Location	Landowner	Description	Recommendations	Cost Est.	Tier Level	Feasi-bility	Benefit	Ranking Priority
C8	New Road	Town	fish passage issues-rocks at culvert outlet could create fish barrier	Clean rocks from culvert outlet	?	1	H	H	6
C9	Upstream from New Road	Private	fish passage issues-undersized and not fully covered with no apparent function. Removal candidate	Need to determine landowner and if culvert is of any use.	?	1	H	H	6
C10	Kala Lane	Private	fish passage issues & partially blocked culvert inlet	Remove debris from culvert inlet	?	1	H	H	6
C14	County Road	MDOT	Culvert under County Road drains an area of wetland has begun to fail and restricts flow and causes flooding	Replace existing culvert with additional overflow culvert at higher elevation-need to check with Ryan	?	3	M	H	5

Appendix F. Identified Structural Retrofit Opportunities

Site	Reach Identification/ Location	Owner	Description	Recommendations	Est. Cost	Tier Level	Feasi-bility	Benefit	Ranking Priority
SR-1	Site 101-Fairfield Inn/ Cummings Road	Private	Existing detention basin non-functioning	convert existing basin to soil media filter or gravel wetland and enlarge by 35%. Replace existing outfall to RB with longer and armoring	210k	2	L		
SR-2	Site 103-Pet Quarters-Paine Rd	Private	Existing stormwater management not functioning	install curb along SE edge of pave-ment, two tree box filters,	244k	2	L		
SR-3	Site #104-United Health Care Southborough Dr - Site #20	Private	roof and pavement trib to three existing basins	convert all three basins to a soil me-dia filter or gravel wetlandand en-large basins, manholes and pipeing would be required to convey existing flow to soil media filter.	516k	2	L		
SR-4	Site #105-Stantec corner of Payne & Cummings	Private	Roof and pavement trib to two small existing detention basins - inadequate treatment	Install four tree box filters for wq treatment, isolator rows conveyance from major storms, then released to town storm drain system	362k	2	L		
SR-5	Site #106 - Payne Road Plaza	Private	Roof and plaza parking pavement trib to exist. Dry detention basin	construct open water wet pond/ detention, install tree box filters discharging to wet pond, naturalize the drainage ditch between the site and Payne rd.	572k	2	L		

Appendix G. Structural Retrofit Designs for Five Commercial Sites



Site Characteristics:

Impervious Area = 1.5 acres +/-

Existing Stormwater Management System – Yes (no catch basins, only piping for roof drain conveyance)

Stormwater Infrastructure Ownership – Private

Roof and pavement tributary to existing dry detention basin

Proposed Retrofit Summary:

Install curb along south east edge of pavement and install two tree box filters to provide water quality treatment of parking area and drives. Treated flow would be diverted around existing dry basin and connect to Payne Rd storm drain.

The existing roof drain would continue to flow to the existing detention basin and not receive formal water quality treatment. The overflow from the tree box filters in major storm events would also be conveyed through an isolator row and then to the existing detention basin.

Estimated Cost:

Construction Cost	= $188,000
Contingency (10%)	= $18,800
Engineering/Permitting	= $37,600
TOTAL	= $244,400

Other Information:

- A roof drain filtration device could be added to provide water quality treatment for roof runoff (not included in estimated construction cost).

DH

Cumberland County Soil & Water Conservation District

0 40 80 Feet N

Data Sources: MEDEP, MEGIS, Town of Scarborough
Date: 06/05/10

Potential Structural Retrofit:
Site ID 103
486 Payne Road

Site Characteristics:

Impervious Area = 8.5 acres +/-

Existing Stormwater Management System – Yes

Stormwater Infrastructure Ownership – Private

Roof and pavement tributary to three existing detention basins.

Proposed Retrofit Summary:

Convert all three existing detention basins to a soil media filter or gravel wetland and enlarge basins as shown. The addition of a series of manholes and storm drain piping would be required to convey flow from existing storm drains to the soil filter/wetland.

The existing outfalls would require some alteration and utilization of proprietary vortex based pretreatment units is expected.

Estimated Cost:

Construction Cost	= $397,000
Contingency (10%)	= $39,700
Engineering/Permitting	= $79,400
TOTAL	= $516,100

Other Information:

N/A

DH

Cumberland County Soil & Water Conservation District

0 100 200 Feet N

Data Sources: MEDEP; MEGIS; Town of Scarborough
Date: 09/09/10

Potential Structural Retrofit:
Site ID 104
300 Southborough Drive

Site Characteristics:

Impervious Area = 1.9 acres +/-

Existing Stormwater Management System – Yes

Stormwater Infrastructure Ownership – Private

Roof and pavement tributary two small existing detention basins

Proposed Retrofit Summary:

Install four tree box filters to provide water quality treatment for the south and west portion of the site. Treated flow and untreated overflow for major storm events will be conveyed through an isolator row. Discharge from the isolator row will be conveyed to the existing detention basin and released to the Town storm drain system.

Reduce the size of the easterly existing detention basin and install two Storm Treat units to provide water quality treatment for the building and the northerly and easterly portions of the parking area.

Estimated Cost:

Construction Cost	= $279,000
Contingency (10%)	= $27,900
Engineering/Permitting	= $55,800
TOTAL	= $362,700

Other Information:

- Utilization of Proprietary vortex based pretreatment units.

DH

Cumberland County Soil & Water Conservation District

0 50 100 Feet

N

Data Sources: MEDEP; MEGIS; Town of Scarborough
Date: 08/05/10

Potential Structural Retrofit:
Site ID 105
482 Payne Road

Site Characteristics:

Impervious Area = 1.9 acres +/-

Existing Stormwater Management System – Yes

Stormwater Infrastructure Ownership – Private

Roof and pavement tributary two small existing detention basins

Proposed Retrofit Summary:

Install two proprietary filter cartridge vaults at the end of the existing storm drain system prior to entering the southern existing detention basin to provide water quality treatment for the building and all parking and drives for the site.

The majority of the existing storm drain will be retained.

Estimated Cost:

Construction Cost	= $163,000
Contingency (10%)	= $16,300
Engineering/Permitting	= $32,600
TOTAL	= $211,900

Other Information:

- Utilization of Proprietary vortex based pretreatment units.

DH

Cumberland County Soil & Water Conservation District

0 50 100 Feet

N

Data Sources: MEDEP; MEGIS; Town of Scarborough
Date: 08/05/10

Potential Structural Retrofit:
Site ID 105
482 Payne Road

Site Characteristics:

Impervious Area = 3.0 acres +/-

Existing Stormwater Management System – Yes

Stormwater Infrastructure Ownership – Private

Roof and plaza parking pavement tributary to existing dry detention swale

Proposed Retrofit Summary:

Construct open water quality wet pond/detention basins in front of the site.

Install tree box filters with interconnected pipes discharging to a wet pond.

Naturalize the drainage ditch between the site and Payne Rd.

Estimated Cost:

Construction Cost	= $440,000
Contingency (10%)	= $44,000
Engineering/Permitting	= $88,000
TOTAL	= $572,000

Other Information:

- Easement required in north east corner of site.

- Option to only construct improvements at the front of the site (water quality ponds and ditch naturalization) and substitute the tree box filters and associated drainage system with an enhanced natural buffer at the rear of the complex.

DH

Cumberland County Soil & Water Conservation District

0 70 140 N
Feet

Data Sources: MEDEP, MEGIS, Town of Scarborough
Date: 08/05/10

Potential Structural Retrofit:
Site ID 106
456 Payne Road