Final Draft Birch Stream Watershed Management Plan

A Plan for Nonpoint Source Pollution Control and Prevention in Birch Stream, Bangor, Maine

Final Draft August 5, 2010

Prepared by the City of Bangor
and the James W. Sewall Company

Funded in part by the U.S. EPA through section 319 of the Clean Water Act and administered by the Maine Department of Environmental Protection.

SEWALL
JAMES W. SEWALL COMPANY / Since 1880

Table of Contents

1.0 INTRODUCTION 8
1.1 PURPOSE AND BACKGROUND 8
1.2 DEVELOPMENT OF THE PLAN 10
1.3 STREAM DESCRIPTION AND WATERSHED CHARACTERIZATION 10
1.4 EXISTING REPORTS 12
1.5 CURRENT STORMWATER EFFORTS 14
1.5.1 STORMWATER PERMITS 14
1.5.2 EDUCATION AND AWARENESS 15
1.5.3 ORDINANCES AND ADMINISTRATION 15
1.5.4 POLLUTION PREVENTION AND GOOD HOUSEKEEPING 16
1.5.5 ENGINEERED STORMWATER TREATMENT SYSTEMS (RETROFITS) 17
2.0 CAUSES OF IMPAIRMENT 19
2.1 WATER CLASSIFICATION STANDARDS AND CRITERIA 19
2.2 MONITORING HISTORY AND STRESSOR IDENTIFICATION 20
2.2.1 PROPYLENE GLYCOL AND BIOLOGICAL OXYGEN DEMAND 21
2.2.2 ELEVATED WATER TEMPERATURE 24
2.2.3 HIGH PEAK FLOWS 25
2.2.4 TOXIC CONTAMINANTS 25
2.2.5 ELEVATED NUTRIENTS 25
2.2.6 EROSION 26
2.2.7 TOTAL SUSPENDED SOLIDS – TSS 26
2.3 TOTAL MAXIMUM DAILY LOAD (TMDL) STUDY 26
2.4 POLLUTANT LOADING 26
3.0 PLAN IMPLEMENTATION 28
3.1 PLAN OWNERSHIP, ADOPTION, AND IMPLEMENTATION 28
3.2 IMPLEMENTATION TIMEING 28
3.3 PARTNERS 28
3.4 POTENTIAL FUNDING SOURCES 29

3.5 FURTHER STUDIES 30
3.6 ANNUAL REVIEW AND ADAPTIVE MANAGEMENT 30
4.0 RESTORATION TOOLBOX 32
4.1 RESTORATION TOOLBOX 32
4.2 BEST MANAGEMENT PRACTICES (BMP) 32
4.3 EDUCATION AND AWARENESS 32
4.4 POLLUTION PREVENTION AND HOUSEKEEPING 37
5.0 RESTORATION TOOLBOX: CHANNEL & RIPARIAN RESTORATION 42
6.0 RESTORATION TOOLBOX: ENGINEERED TREATMENT SYTEMS (RETROFITS) 46
6.1 ENGINEERED RETROFITS 46
6.2 DESIGN CONSTRAINTS 46
6.3 PRIORITIZING PROPOSED RETROFITS 47
6.3.1 Upper Sub-watershed Proposed BMP Retrofits 47
6.3.2 Lower Sub-watershed Proposed Retrofits 48
6.3.3 East Sub-watershed Proposed Retrofits 48
6.3.4 Center Sub-watershed Proposed Retrofits 48
6.3.5 West Sub-watershed Proposed Retrofits 50
7.0 RESTORATION TOOLBOX: ORDINANCES & ADMINISTRATION 55
7.1 ORDINANCES 55
7.2 ADMINISTRATION 55
8.0 MILESTONES AND FUTURE MONITORING EFFORTS 59
8.1 ADAPTIVE MANAGEMENT 59
8.2 MEASURABLE MILESTONES 59
8.3 WATER QUALITY MONITORING 62
9.0 REFERENCES 64
10.0 APPENDICES 65
10.1 Appendix A – Integrated list of Best Management Practices 65
10.2 Appendix B - Focus Area Descriptions and Details by Sub-Watershed 65
10.3 Appendix C – Water Quality Calculations for Priority Sites
10.4 Appendix D - Complete Benthic Modeling Data 65

List of Abbreviations Used in the Plan

BIA	Bangor International Airport
BMP	Best Management Practices
EPA	Environmental Protection Agency
IP	Implementation Plan
MDEP	Maine Department of Environmental Protection
TMDL	Total Maximum Daily Load
WMP	Watershed Management Plan

Acknowledgements

James W. Sewall Company (Sewall) wishes to thank the City of Bangor (City) and the Maine Department of Environmental Protection (MDEP) for choosing Sewall to assist in developing this plan. Working together, a comprehensive and well-designed approach to enhancing water quality has been achieved.

Funding for this project, in part, was provided by the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act. Section 319 grants are administered by the MDEP in partnership with EPA.

The following list of Stakeholders represents those present at meetings hosted by the City to provide information and gather input. The plan does not necessarily represent the views of these individuals, but rather, is a series of potential recommendations that were summarized from numerous sources including sources from outside of the Stakeholder meetings.

Stakeholders:

John Bielamowicz	Maine Army National Guard
William Ball	University of Maine, Cooperative Extension Service
Ed Barrett	City of Bangor
John Barron	Resident & Business Owner
Stephen Barnes	Resident
Charles Birkel	Resident
Ann Birmingham	Resident
Sandy Blood	General Electric
Steve Bolduc	City of Bangor
Sid Buzzell	Resident
Tony Caruso	Bangor International Airport
Lisa Chan	Asian Palace
Elsie Coffey	Bangor Housing Authority
Florence Conley	Resident
Lt. John Cronin	Maine Air National Guard
Mary Ellen Dennis	Maine Dept. of Environmental Protection
Jeff Dennis	Maine Dept. of Environmental Protection
Nancy Foster	AAA Northern New England
Dr. Geoff Gratwick	City Councilor
Jeff Gordon	Griffin Park/Bangor Housing Authority
Karl Gurschick	Gurschick Bros. Realty
Debra Zarta Grier	NHSC Inc. Consulting
Norm Heitmann	City of Bangor

Sherry Haller	Union Street Athletics
Brenda Hallisey	Resident
Rebecca Hupp	Bangor International Airport
Louis Jamison	Resident
Col. Eric Johns	Maine Air National Guard
Deborah Kelley	Maine Air National Guard
David Luce	Resident
Rodney Madden	Bangor International Airport
John Murphy	City of Bangor
Paul Nicklas	City of Bangor
Jerry Palmer	City Councilor
Heather Parent	Eaton Peabody
Amanda Plourde	Bangor International Airport
Earle Refuse	Citizen
James Ring	City of Bangor
Rebecca Roche	Maine Dept. of Environmental Protection
Catherine Schmitt	Citizen
Todd St. Peter	Eastern Maine Healthcare
Norma Sullivan	Resident
Jessie Tyler	Bangor International Airport
Mark Ward	City of Bangor
Wendy Warren	City of Bangor
Dan Wellington	City of Bangor
Judith Williams	Resident
Keith Woodard	Midas

The City would like to thank the following environmental and engineering firms for their contributions to the work which came before this plan was drafted; James W. Sewall Company for water quality monitoring, SMRT for work in developing and overseeing stormwater treatment systems at Bangor International Airport (BIA), BSA Environmental for development of BMPs for the Penjajawoc watershed designed for city-wide implementation which are also included in this plan, CES for water quality monitoring for the City and BIA, and Edwards & Kelcey for their work in updating the BIA drainage study.

Executive Summary

This document is a watershed management plan for Birch Stream, a tributary to the Kenduskeag Stream, located in the City of Bangor, Penobscot County, Maine. Both streams are a tributary to the Penobscot River, Penobscot Bay, and ultimately the Atlantic Ocean. According to City records, the Birch Stream watershed encompasses a total of 1,870 acres which includes 244 commercial, industrial, governmental, and residential properties within its boundaries (see Figure 1.0).

The stream is categorized as impaired by Maine Department of Environmental Protection. The source of pollutants which have lead to the impaired status of Birch Stream has not been specifically identified, because there are many different origins. All daily activities that are conducted in the area that drains to a stream are potential sources of pollution. For example, streets, gas stations, fast food restaurants, grocery stores, banks, auto repair shops, and bus depots may contribute petroleum leaks, drips, and spills from the coming and going of hundreds of vehicles. These residual chemicals accumulate into measurable pollution when they get washed away each time it rains. The residue can be seen clearly by the naked eye as a rainbow colored "sheen" on a parking lot during a light rain. Additionally, fertilizers, pesticides, and pet waste can end up being washed into the stream.

Historically, military installations were developed and operated with the concept of environmental protection low on the list of priorities, especially in time of war. Unfortunately, the Birch Stream has been a receptor for many of the contaminants that may have been inadvertently washed away with rain water throughout the years.

No one organization is responsible for the accumulation of contaminants which has occurred over time. Development of urban areas has increased and most urban areas have facilities and buildings that were built when no stormwater treatment systems were required or were provided stormwater treatments that are inadequate under modern (today's) standards. These substandard facilities are contributing contaminants and unchecked volumes of stormwater with each storm event. All of the facilities and buildings within the drainage area of the stream will need to have some type of stormwater control put into place if we are to improve the water quality of Birch Stream. Additionally, the infrastructure (stormwater sewers) that is in place underground to convey stormwater is aging and in need of repair. The most cost effective and practical way to do this is to prioritize those sites that affect the stream most severely. Areas that abut the stream, areas that avail themselves to high volumes of vehicular traffic, or have a high potential for contamination, have no

existing treatment, and those with large areas of impervious cover are at the top of the list of priorities.

This plan is an attempt to manage the multitude of action items that will need to be implemented in order to improve the water quality of the stream. By creating a list of best management practices that have been shown to improve water quality in other places, identifying potential funding sources, anticipating landowners cooperation, and undertaking an adaptive planning approach we anticipate these activities will have a positive impact on the stream. Failure to see these attempts to fruition has, in other areas, resulted in more costly consequences, with the largest burden falling on individual commercial and retail entities, eventually affecting the community as a whole. This is the reason why the City has chosen to take the lead in developing this watershed management approach. Coordination among partners, identifying funding, and planning will be necessary in order to implement the plan in the most cost effective manner. Cooperation among all of the entities in the watershed will be essential to keeping this a vibrant, economically stable community.

The Maine Air National Guard and the Bangor International Airport are to be commended for consistently and continuously committing countless hours of time, concern, and dollars to improving the condition of stormwater discharge in the Birch Stream Watershed over the past decade, and for their continued commitment to the implementation of this plan.

1.0 Introduction

1.1 PURPOSE AND BACKGROUND

The United States Department of Defense increased military flights leaving Bangor International Airport (BIA)A during the winters of 2001, 2002 and 2003 in response to the September 11, 2001, attack on United States targets. The increase in military flights necessitated a drastic increase in use of de-icing fluid as planes stood on the tarmac, ready to be placed into service at a moments notice. These aircraft had to be doused with de-icing fluid almost continuously to ensure their immediate strategic deployment in support of our nation's defense. At about the same time, residents in the watershed began to complain of the odor caused by the breakdown of de-icing fluid in the stormwater system. The media became involved as well as Maine Department of Environmental Protection (MDEP), the City, and the Maine Air National Guard (MEANG). In

response, the City designed and installed a system for collecting, storing, and redirecting de-icing fluid runoff to the sanitary sewer system. The system included storage capacity of up to 150,000 gallons at a final cost of approximately $1.5 million. The MEANG followed suit with a similar system in November, 2003. The total cost to date for deicing collection and recovery systems for both agencies in infrastructure alone is now over $4 million.

In response to the media attention, and resident complaints, Birch Stream became a primary focus of the MDEP. Birch Stream was subsequently determined by the MDEP to be an impaired water body as defined by section 303(d) of the Clean Water Act (CWA) for failure to achieve established water quality standards for aquatic life and dissolved oxygen. The MDEP prepared a Total Maximum Daily Load (TMDL) Report that summarizes sampling data, identifies general types of pollutants, and sets a goal to meet water quality classification attainment. The first draft of this report was released in August, 2005. Once such a designation is established, the U.S. Environmental Protection Agency (EPA) and MDEP require municipalities to develop and implement stormwater management improvements in order to help impaired waters to meet established water quality standards. All reports that are mentioned in this plan can be found on the City's Stormwater Webpage located at http://www.bangormaine.gov/cs_stormwater.php .

A Watershed Management Plan (WMP) creates a framework for identifying and prioritizing remedial actions, also called Best Management Practices (BMPs), intended to reduce the quantity and quality of runoff that contributes pollutants and uncontrolled flow from developed areas. The core of this WMP includes a set of actions and storm water BMP alternatives presented in Sections 4-7. This Plan follows the federal guidance for watershed management plans published by the EPA reference number EPA-841-B-08-002, located at the following URL; http://www.epa.gov/owow/nps/watershed_handbook/ .

1.2 DEVELOPMENT OF THE PLAN

The City, BIA, and MEANG began working to improve Birch Stream in 2002. In August of 2005, when the first draft of the Birch Stream Total Maximum Daily Load (TMDL) report was released, the City organized a planning committee and stakeholders were notified of the opportunity to participate in planning efforts. The City received 319 funding from DEP in 2008 to hire consultants to help write this plan. Stakeholders have been notified of opportunities to participate through individual letters, telephone, e-mail, media releases, and television coverage whenever meetings were held.

Bangor City Councilors have also been periodically apprised of stormwater management principles and concerns and the need for development and implementation of watershed management plans. City Councilors, along with Stakeholders, have had the opportunity to attend presentations that explain the plan and its elements and offer comments and suggestions. Council members and stakeholders also have the opportunity to review the plan in its draft form and comment on it before it is sent to MDEP for approval. After the watershed management plan has been approved by the MDEP, the City Council will be asked to adopt it. The City Council generally directs stormwater policy and decision making to go before the Infrastructure sub-committee. The committee may choose to hold a public hearing if it is deemed necessary.

The MDEP has been involved with the City throughout the development of the plan and representatives of MDEP have attended every public meeting. In addition, they have assisted by reviewing documents, providing useful input during meetings, offering suggestions, and supporting the City's efforts to locate funding during the development of the plan. Suggestions and data from MDEP studies have been incorporated into this report.

1.3 STREAM DESCRIPTION AND WATERSHED CHARACTERIZATION

Birch Stream is a small tributary to the Kenduskeag Stream. Both streams are a tributary to the Penobscot River, Penobscot Bay, and ultimately the Atlantic Ocean. According to City records, the Birch Stream watershed encompasses a total of 1,870 acres which includes 244 commercial, industrial, governmental, and residential properties within its boundaries (see Figure 1.0).

The natural portion of Birch Stream has been defined by MDEP as the approximately 0.5 mile segment flowing from the north of the Airport Mall to its confluence with Kenduskeag Stream. The natural portion of the stream flows past several recently constructed high-density residential developments before passing under Ohio Street and cascading over a waterfall and into the Kenduskeag.

Figure 1.0 Birch Stream Watershed

For the purposes of this watershed management plan, the Birch Stream watershed was divided into five sub-watersheds. This approach permits the prioritization of areas that would be best suited for new or retrofitted BMPs. Figure 1.1 shows the sub-watershed boundaries overlaid on an aerial photograph. The areas of highest priority are the upper and lower sub-watersheds. These areas were chosen because of the high amount of impervious area and the type of development located within the sub-watershed boundaries.

The upper watershed is dominated by BIA, which was constructed on the site of the former Dow Air Force Base. Dow Air Force Base was constructed in the 1940's. The current airport complex is approximately 33% impervious and includes terminals, hangars, taxiways and runways, service aprons, and parking lots. The Airport runoff is collected through a series of culverts, drainage ditches and canals that ultimately transport the runoff northward towards a large box culvert under Union Street and the Airport Mall. The box culvert outlet at the rear of the Airport Mall officially marks the head of the "natural" section of Birch Stream.

The lower sub-watershed is made up of several commercial properties and is approximately 54% impervious. This watershed includes areas of high vehicular traffic such as a mall, a restaurant, a

gas station and convenience store, a car wash, a bank, two fast food restaurants, a bus station and a golf driving range. Improving the stormwater treatment and abating excess flow impacts in this sub-watershed will greatly improve the water quality and stability of Birch Stream since this runoff currently flows directly into the stream without treatment. The lower sub-watershed runoff is collected through a series of catch basins and outlets to the box culvert under the Airport Mall that empties into the natural portion of Birch Stream.

The center sub-watershed has several commercial properties within its boundaries including office buildings, a bank, an auto dealership and other businesses. This sub-watershed is approximately 52% impervious. A portion of the runoff within the center watershed is collected through a series of catch basins and outlets and ditches draining to the large box culvert that passes under Union Street and continues under the Airport Mall.

The east sub-watershed also consists of properties including the Maine Army National Guard (MEARNG), Bangor Public Works, a large manufacturing facility, a portion of the University College of Bangor, two healthcare malls and several fast food restaurants, an auto repair garage, a and a gas station. This watershed is approximately 50% impervious. The runoff from this watershed collects in a series of catch basins which also convey the water to the canal and subsequently to the box culvert under the Airport Mall.

The majority of the west sub-watershed consists mostly of residential properties, athletic fields and the Penobscot Job Corps Campus. This watershed is approximately 19% impervious. The runoff from the west watershed is also collected in a series of catch basins and is conveyed through a culvert under Griffin Road to Birch Stream.

1.4 EXISTING REPORTS

A special study entitled Urban Streams Non-point Source Assessments in Maine: Final Report was completed by MDEP in February of 2005 and featured Birch Stream as one of four typical urban impaired streams in Maine. Subsequently a Total Maximum Daily Load (TMDL) study was completed in September of 2007 for Birch Stream by MDEP as required under the CWA titled "Birch Stream Total Maximum Daily Load (TMDL) Report" #DEPLW0715. The MDEP's Implementation recommendation states that the City must implement BMPs and remedial actions in a cost-effective manner using an adaptive management approach to improve water quality to meet the standards that have been set. All reports can be found on the City's Stormwater webpage at http://www.bangormaine.gov/cs_stormwater.php .

Water quality assessment reports are summarized in Section 2.2. No geomorphology studies or modeling have been completed for Birch Stream, although, extreme damage of the stream banks is evident by visual inspection.

Figure 1.1 - Sub watershed Boundaries

A Stream Corridor Survey was conducted by volunteers from the AmeriCorps NCCC (National Civilian Community Corps) directed by the City, in August 2009, and summarized by the Maine Department of Environmental Protection Maine Stream Team Program in a report titled Arctic Brook, Birch Stream, Capehart Brook, and Shaw Brook Watersheds Stream Corridor Survey Summary Report, March 2010. The study is cursory in nature, but provides a quick summary of areas of highest priority. Volunteers briefly assessed the geology, riparian areas, stream bottom and channel conditions, and undertook a visual biological survey.

Funding is always the first concern when new programs and/or new infrastructure are added or updated. As a result, CH2MHill was contracted to conduct a Stormwater Rate Update Analysis Report,CH2MHill, August 2009, which was an update of a previous feasibility analysis for a utility district fee structure. The objective of a utility district fee structure is to provide a more equitable distribution of the costs of improvements. Similar to a fee for water or sewer use, the fee would be based upon use of the stormwater system infrastructure and the cost to maintain the system. The updated feasibility analysis was completed in August 2009. The analysis used the Birch Stream Watershed as a model for the conceptual program. The report summarized that if the cost to improve the stormwater system in the Birch Stream Watershed were spread out among all properties in the watershed, the cost to the average household might be between $40 to $80 dollars a year while the average commercial property (3 acres) might pay from $120 to $240 per year. The City feels this amount may be exaggerated since exact budget figures were not available at the time of the study, and estimates of impervious areas by type of property were not exact, but based upon national averages.

1.5 CURRENT STORMWATER EFFORTS

1.5.1 Stormwater Permits

Traditional definitions of storm water have usually characterized it as non-point source runoff. However, most urban and industrial storm water is discharged through separate storm sewers, ditches, channels or other conveyances, which are considered point sources under the CWA, and subject to regulation through the National Pollutant Discharge Elimination System (NPDES) permit program.

Maine is an authorized state under the federal permitting program. MDEP administers the federal program pertaining to the municipal separate storm sewer systems (MS4s) and construction activities as part of the Maine General Permit for the Discharge of Storm water from Small Municipal Separate Storm Sewer Systems authorized under State Water Pollution Control Law, 38 M.R.S.A. § 413, *Waste Discharge Licenses*. Additionally, individual permits may be required for significant commercial and industrial sources under the Maine Pollution Discharge Elimination System (MEPDES) permit program.

A large portion of the watershed is covered by two individual Phase II MPDES permits, one for the Maine Air National Guard and one for BIA. These permits were originally issued in 2001 and 1991 respectively. The latest MPDES permits were issued in 2005 and will be renewed in 2010. The City also has an MS4 permit issued by the State authorized in 2003. The existing MS4 permit for the City of Bangor requires six minimum control measures to be addressed as well as the implementation of additional controls in watersheds of impaired streams.

The City's Fleet Maintenance Department, maintains a Multi-Sector General Permit for stormwater discharge associated with industrial activity. The permit required the development of a Stormwater Pollution Prevention Plan (SWPPP) which was approved by MDEP on February 10, 2009. The SWPPP includes quarterly monitoring of the stormwater system and BMPs that have been implemented. Fleet Maintenance also has a Spill Prevention Control and Countermeasures Plan (SPCC) required by the State of Maine due to the quantity of petroleum product stored on site.

1.5.2 EDUCATION AND AWARENESS

The City is a member of the Bangor Area Stormwater Group (BASWG) which has worked closely with MDEP to conduct education and outreach activities, not only in the Birch Stream watershed, but this entire segment of the Penobscot River. The City, in conjunction with the Bangor Area Stormwater Group, initiates numerous activities to raise awareness and improve understanding of stormwater principles such as conducting training sessions, developing demonstration sites and educational materials, and conducting training in elementary schools. Along with other municipalities in the State, the BASWG developed and aired an advertisement that raises awareness about the substances that pollute stormwater and that stormwater drains to the river, lakes, or ocean. Additionally, the BASWG has a useful website, located at: http://www.baswg.org that highlights best management practices for homeowners and business owners. The City has also produced a webpage located at: http://www.bangormaine.gov/cs_stormwater.php , which provides access to information and documents relating to Birch Stream and other priority watersheds in the City.

City employees whose work activities could affect stormwater quality are trained annually on stormwater pollution prevention practices, spill control and clean up, soil erosion control, sand and salt management, and other best management practices as appropriate.

1.5.3 ORDINANCES AND ADMINISTRATION

The City has worked diligently to meet MS4 permit requirements with regard to new ordinance requirements. In some cases, the City has gone above the minimum in order to create a level playing field for development throughout the City. The City's code of ordinances can be found on the City website. City staff has conducted a comparison of ordinances relating to stormwater based on the Center for Watershed Protection Handbook. Recommendations for improvements are included in Section 7 titled Restoration Toolbox: Ordinances and Administration.

Parks Sanitation § 231-4 Pet Waste Disposal

Chapter 231, section 4 (C), requires pet owners to collect and dispose of pet waste properly while in public parks. City has installed pet waste stations that dispense plastic baggies and a place to dispose of used baggies in parks. An early identified problem is that some pet owners don't want to carry the waste to the next waste disposal container, rather they deposit it wherever they stand. Additionally, some residents deposit pet waste into the nearest. Outreach and enforcement will be needed to change this behavior.

Illicit Discharge Ordinance: § 197-2 Non-Stormwater Discharges

This ordinance prohibits non-stormwater discharges to the storm drainage system, and describes enforcement actions such as cessation of practices, and abatement at the violator's expense, penalties, fines and/or consent agreements.

Post Construction Maintenance Ordinance: § 268- Stormwater Maintenance
This ordinance ensures that stormwater management structures are properly maintained to safeguard the public and the City's natural resources to the maximum extent practicable. This chapter also seeks to ensure compliance with the post-construction stormwater management minimum control measure required by Maine's Small Municipal Separate Storm Sewer Systems General Permit, as well as the requirements of watershed management plans that address watersheds in the City.

Soil Erosion Control: § 165-33.1 Best Management Practices
Any person who conducts, or causes to be conducted, an activity that involves filling, displacing, or exposing soil or other earthen materials shall take measures to prevent unreasonable erosion of soil or sediment beyond the project site or into any portion of a stormwater conveyance system or into a protected natural resource as defined in § 38 M.R.S.A. § 480-B. Erosion control measures must be in place before the activity begins. Measures must remain in place and functional until the site is permanently stabilized. Adequate and timely temporary and permanent stabilization measures must be taken and the site must be maintained to prevent unreasonable erosion and sedimentation.

1.5.4 POLLUTION PREVENTION AND GOOD HOUSEKEEPING

The overall goal of pollution prevention and housekeeping measures is to prevent the release of pollutants so that they are not available for mobilization by runoff. Several management strategies are already in place but could be improved or expanded.

Street Sweeping
For many years the City of Bangor has been sweeping streets at the onset of Spring. The original intent of street sweeping was to keep down dust caused by vehicular traffic driving over residual sand in the City Center. Today the intent is two fold – to prevent particulates in the air, and to reduce the amount of sediment that settles into catch basins and outfalls. The City owns three street sweeping machines, one of which is a state of the art vehicle picking up particles that meet the California PM10 standard for air particulates. Two crews sweep streets around the clock as soon as the snow melts and continue well into the spring and summer. They concentrate on the downtown area as well as in priority watersheds of impaired streams. Approximately 50 cubic yards of street sweepings are collected, recycled, and/or disposed of annually.

Catch Basin Cleaning
Many of the storm water systems in the watershed were constructed before storm water quality and quantity standards were developed by the City or State. These rudimentary storm water systems were designed to efficiently convey the storm water to a discharge location rather than to treat it prior to discharge. The catch basins in these systems were designed with sumps that act to remove coarse sediment before it gets into the culverts. To be most effective, these sumps are vacuumed periodically to remove accumulated sediment. The City focuses on areas known to rapidly accumulate sediment, such as areas that are located on the downhill slopes of roads. The number of catch basins that get cleaned each year is limited by antiquated equipment which is inefficient and requires frequent repair.

Formerly Used Defense Sites Clean Up
Many City-owned properties around the airport complex were previously used by Dow Air Force Base in the 1950's and 1960's. Some areas are known to have potential for contamination and are being addressed through the U.S. Army Corps of Engineers FUDS schedule of activities, including

the Potential Responsibility Party determination. The City has bypassed this time consuming process on a few occasions, where pipelines were found to be in urgent need of abatement and permanent closure. In these cases, the City becomes responsible for the cost of clean up. One of the known sites (adjacent to the Public Works Department) is currently being assessed with funding and assistance from the Maine Department of Environmental Protection Brownfields program. It is expected that clean up measures as recommended by the resulting assessment will be undertaken so the site can be certified by DEP to be suitable for redevelopment.

1.5.5 ENGINEERED STORMWATER TREATMENT SYSTEMS (RETROFITS)

Propylene Glycol Recovery

Propylene Glycol is a deicing agent mixed with water at various concentrations sprayed on airplanes as a safety measure to keep the ice off of wings during take off and in flight. Installation of a Propylene Glycol Recovery system was completed in 2003 at BIA and 2004 at MEANG. The systems are made up of designated de-icing areas that collect snow melt and residual de-icing fluid, transferring it to underground containment systems that automatically meter product to the Waste Water Treatment Plant. The cost of both systems exceeded $4,000,000 and continuing maintenance of these systems is expensive.

Public Works and Fleet Maintenance Facilities

In 2004 the City invested $375,000 to install a state-of-the-art, self-contained wash bay for heavy equipment and street sweepers and an automatic touchless vehicle wash system using recycled and reclaimed water, the first of its kind in the State. The new wash bay filters solids and pollutants from wash water as it is recycled for further use. In 2009 the Fleet Maintenance Department spent over $13,000 to install two oil/water separators and a spill containment system, designed to contain spills of up to 900 gallons. In 2008 and 2009 the City invested approximately $17,000 at its Public Works site to clean and permanently close several underground military pipelines that were historically used by Dow Air Force Base, to carry fuel to the airport. Additionally, Public Works installed 17 new catch basins with sumps, polyethylene traps and filters. The filters were designed to trap total suspended solids (TSS), phosphorus, hydrocarbons, and heavy metals. The new catch basins were retrofitted to the existing system.

Airport Stormwater System

BIA's drainage system was studied and mapped by Edwards and Kelcey in 2007. Numerous recommendations for updating the aging stormwater infrastructure were included in this plan.

Concept designs for improving stormwater treatment were developed by SMRT, Inc. in January of 2009. These design solutions are incorporated into this management plan. The Bangor International Airport Stormwater Design Services, Final Design Report provided by SMRT, Inc. dated January 2009 is incorporated by reference as an appendix to this plan. As a result of funding through the American Recover and Reinvestment Act (ARRA) of 2009, many of the design solutions were constructed in the fall of 2009 and spring of 2010. Half of the two million dollars received through the ARRA will be paid back as a no-interest loan.

Sewer Improvements

The City began separating its combined sewer overflow (CSO) system in 1991. The CSO Master Plan is nearly complete at a cost of $43 million. The system has approximately 900,000 linear feet of sewer lines with approximately 75% of the existing system separated. All combined sewers in

Birch Stream have been separated into individual sanitary and storm water systems. The City has a full time crew of seven personnel that investigate sewer line problems, inspect infrastructure, track illicit connections, and download data from overflow monitoring stations.

2.0 Causes of Impairment

2.1 WATER CLASSIFICATION STANDARDS AND CRITERIA

Birch Stream is a minor tributary to Kenduskeag Stream and then to the Penobscot River. As such, it is defined as a Class B stream by the Maine Department of Environmental Protection in 38 MRSA 467.7.F. 38 MRSA 465.3.A defines Class B waters as:

> *"Class B waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as unimpaired."*

The minimum water quality standards for Class B surface waters under Title 38, MRSA §465) are:

Dissolved Oxygen	7 ppm at 75% saturation
Bacteria (*E.coli*)	64/100 ml (geometric mean) or 236/100 ml (instantaneous level)
Habitat	Unimpaired
Aquatic Life (biological)	Discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.

Birch Stream discharges to Kenduskeag Stream just below Bullseye Bridge on the Griffin Road. This segment of Kenduskeag Stream is defined as lower quality Class C, water (38 MRSA 467.7.F.3). 38 MRSA 465.3.A defines Class C waters as:

> *"Class C waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as a habitat for fish and other aquatic life."*

Dissolved Oxygen	5 ppm; 60% saturation
Bacteria (*E.coli*)	126/100 ml (geometric mean) or 236/100 ml (instantaneous level)
Habitat	habitat for fish and other aquatic life
Aquatic Life (biological)	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.

Under the anti-degradation policy established by Maine; "existing in-stream water uses and the level of water quality necessary to sustain those uses, must be maintained and protected." This requires MDEP to consider all uses including aquatic life, wildlife, recreation, and social significance when determining "existing uses".

2.2 MONITORING HISTORY AND STRESSOR IDENTIFICATION

Maine has a continuous biological monitoring program under the direction of MDEP and has established biological criteria for the different classes of rivers and streams in Maine (38 MRSA §465). The bio-monitoring program uses a tiered approach to protecting aquatic life uses, and assesses the health of rivers and streams by evaluating the composition of resident biological communities (primarily benthic macroinvertebrates), in conjunction with direct measurement of the chemical and physical qualities of the water (e.g., dissolved oxygen, pH, conductivity, temperature and levels or concentrations of toxic contaminants). This biological assessment approach is useful for small streams impaired by storm water runoff and the mix of associated pollutants. Because of their life cycle stages in water, benthic (bottom dwelling) organisms are affected by the full range of environmental influences and thus act as continuous monitors of environmental quality. The approach is not useful for planning purposes, since it does not discriminate between or identify which specific stressors are affecting the benthic community. As such, the approach has limited use in determining which stressor should, and in what order, be addressed.

The assessment that Birch Stream was impaired was based upon data collected by MDEP monitoring of the macroinvertebrate (aquatic insect) communities at station S312 in 1997 and 2001, and at stations S312 and S384 in 1999. The location of these stations is shown in Figure 2.0. The aquatic life criteria set for a Class B stream were not met in any sampling event, and in three out of six sampling events Maine's minimum aquatic life criteria (Class C) were not met. In addition, in 2004, samples collected at S312 did not meet Class C criteria but samples collected at S684 did. Monitoring results were documented in the MDEP's Surface Water Ambient Toxics Sampling results and assessment information is provided in Program Reports completed by MDEP for the years 2000, 2001, 2002 and 2004 as well as an the Urban Streams Project Report completed in 2005.

In recent years only stations S312 and S682 have been consistently monitored. S312 has a nine year data record and S682 a three year data record. The data show that in stream impairment of the macroinvertebrate community has persisted through 2007 for both station S312 (Figure 2.1), and station S684 (Figure 2.2). Complete benthic modeling data are included in Appendix E. It

should be noted that there is a high probability that the impaired status of this stream has existed for several decades given the pre-existing and current development in the watershed which includes the BIA and the City's first shopping mall.

The stressor identification process yielded a list of five identified stressors that are a product of storm water runoff. These are propylene glycol, elevated water temperature, toxic compounds, as well as elevated levels of nitrogen and phosphorus. Each of these stressors has the potential to produce biological impairments. However, it is more probable that the combination of these stressors is responsible. The stressor analysis also revealed that there are no discrete point source discharges in the watershed.

2.2.1 Propylene Glycol and Biological Oxygen Demand

The §303(d) list of impaired waters compiled by MDEP in 2002 and 2004 note "aquatic life" as the impaired use for Birch Stream with urban non-point source runoff from the airport's winter de-icing, which uses propylene glycol, as one potential source for the impairment. Propylene glycol is a non-toxic liquid that is not fully captured by the BMP's installed at the airport and MEARNG facilities. During precipitation events the water mixed with residual propylene glycol washes off the runways and enters the storm water system. As it decomposes, the propylene glycol exerts a demand for oxygen from the stream, and creates a sweet, yeasty odor.

This oxygen demand is one of the stressors that make Birch Stream unable to attain the water quality standard for dissolved oxygen and adversely impacts the aquatic community. This is especially true during the warmer months of summer and fall. In 2003, MDEP conducted a diurnal (24-hour) water quality study of Birch Stream dissolved oxygen. Figure 2.3 shows the result of this study for a 24 hour period during the month of August 2003. The data shows that the stream cannot sustain a dissolved oxygen level consistent with established water quality standards over a 24 hour period. It should be noted that while propylene glycol exerts substantial oxygen demand as it decomposes. Other factors also influence oxygen demand, such as elevated temperature, elevated nutrients, and time of day.

Figure 2.0 - Location of DEP Monitoring Stations

Figure 2.1

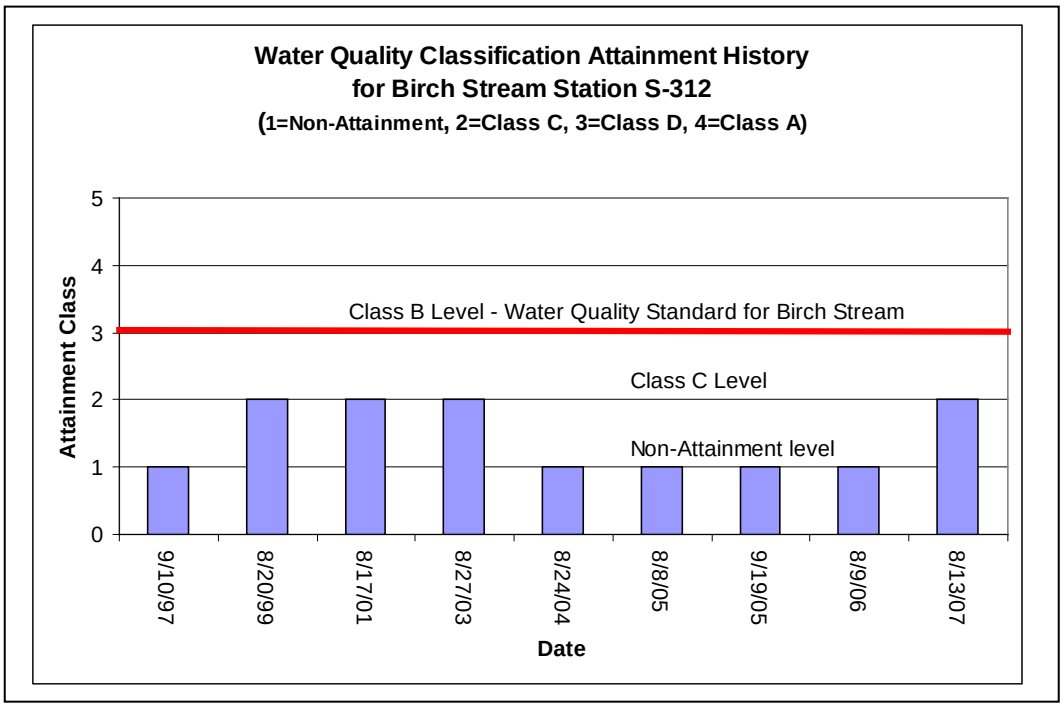


Figure 2.2

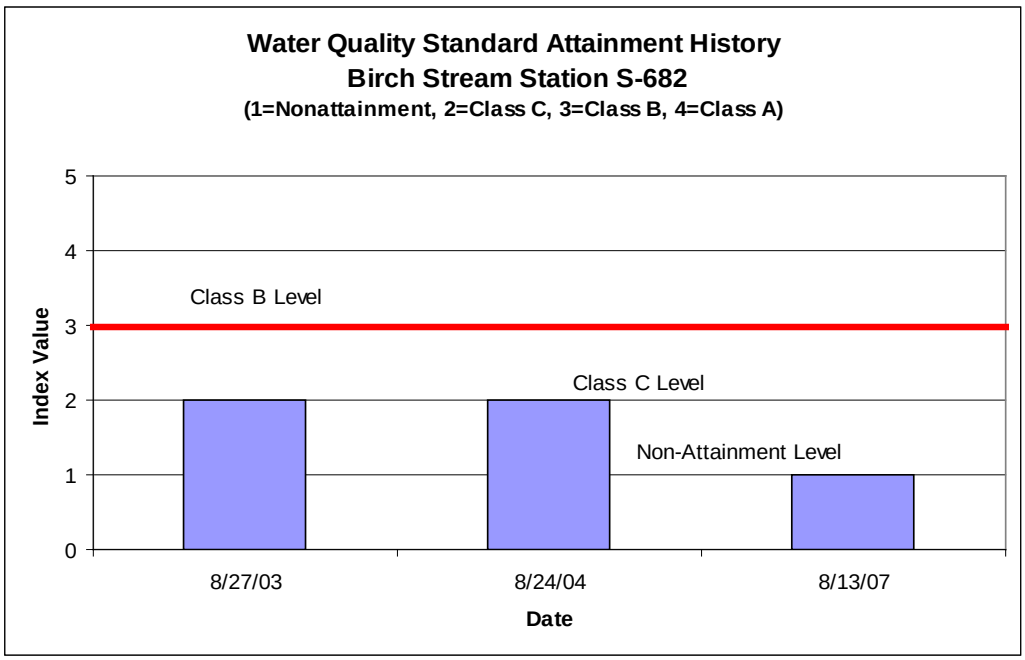
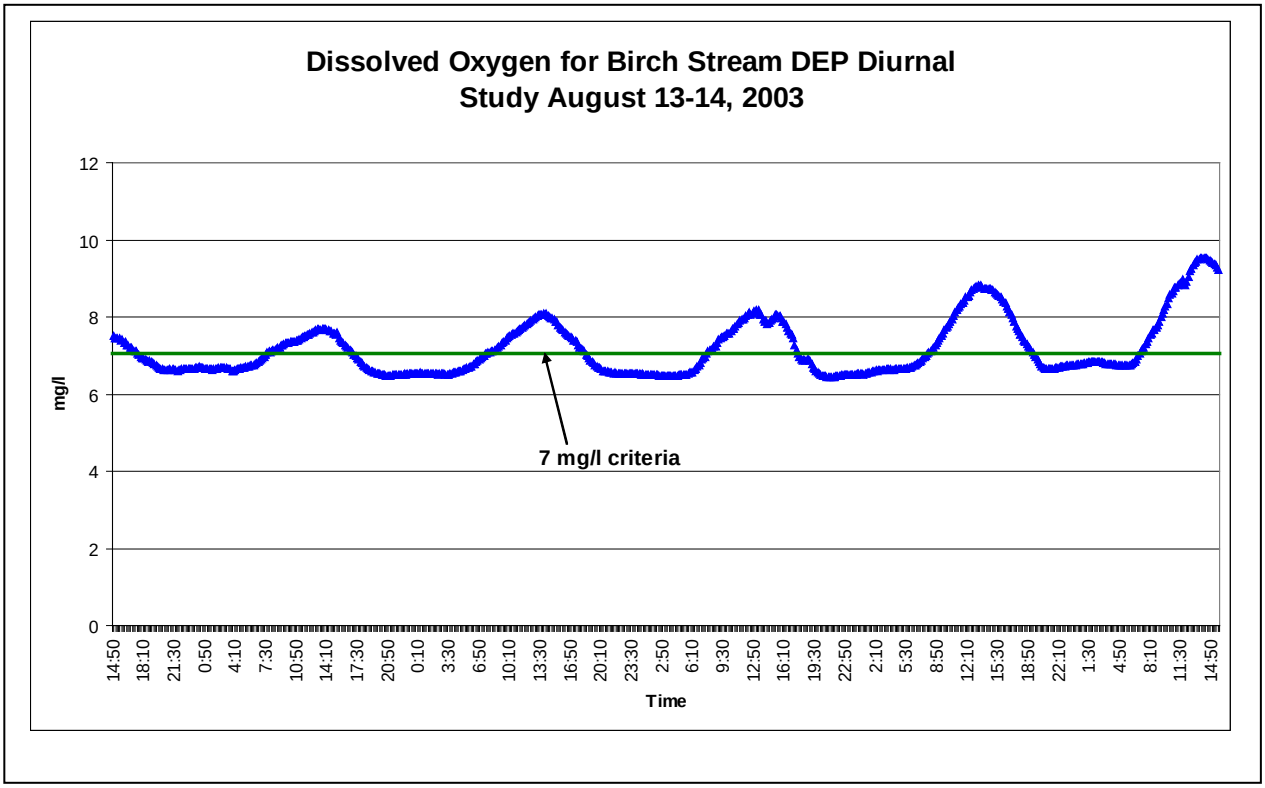


Figure 2.3



2.2.2 Elevated Water Temperature

Paved surfaces capture incoming solar radiation and store this energy as heat. During a rainfall event runoff washes over the heated surface and transfers the heat from the pavement and other impervious surfaces to the nearest stormwater conveyance system, and ultimately, to the stream. Impervious areas include roof tops, parking areas, side walks, and streets. This heat transfer can be particularly high during the period from spring through fall and is highest during the first hour of a significant rainfall event.

Additionally, warmed runoff water can not contain as much dissolved oxygen as cooler water. This causes stress on the aquatic system since some aquatic biological communities have a very narrow range of temperature and oxygen tolerance. Heated run off, even under brief rainfall events, can negatively impact such communities, reducing their diversity and the total number of organisms present. This effect is common in urbanized areas and is a function of the relationship between elevated water temperature and lower levels of dissolved oxygen.

Significant additional contributions of elevated water temperature may come from existing storm water impoundment detention ponds whose waters are exposed to solar radiation for extended periods prior to a rainfall event. These systems contribute water which is normally higher in temperature than free flowing streams.

2.2.3 High Peak Flows

There are four storm water outfalls in the Birch Stream drainage. Two of these outfalls enter at the culvert beneath the Airport Mall, and another is located immediately above Ohio Street. A residential facility, Sunbury Village has a storm water treatment pond on a bluff above the natural portion of the stream. Another recent development dominates the left bank of the stream immediately downstream of the Airport Mall. This new project has modern storm water management facilities and is considered to be best available technology (BAT) implying that it does not have a significant impact on the stream's water quality.

The entire upper watershed is dominated by two facilities, Bangor International Airport and the Maine Air National Guard Base. Each has storm water detention structures that discharge to the channelized upper watershed areas, including storm water treatment ponds, all of which enter the stream just upstream of the box culvert under Union Street and the Airport Mall.

In 2003 MDEP undertook a study of specific stressors and their sources related to urban non-point source pollution in Birch stream. The report entitled, "Urban Streams Non-point Source Assessments in Maine" included a geo-morphological survey which recorded evidence of erosion attributable to increased peak flows related to the large areas of impervious surface in the watershed (*e.g.* runways, roads, parking lots, roofs, driveways etc.). This has been confirmed by recent studies conducted in the watershed in 2007 and 2008.

2.2.4 Toxic Contaminants

The Urban Streams Report mentioned above, found that several toxic contaminants exceeded relevant criteria in a number of sampling events. Aluminum exceeded Maine's Statewide Water Quality Criteria (SWQC) CMC (Criteria Maximum Concentration) during stormflow conditions in November 2003. Certain semi-volatile organic compounds (SVOCs; PAHs and benzidine) exceeded Maine guidelines for remedial actions and/or EPA remediation goals during baseflow conditions in June 2003. The role of toxic contaminants as a stressor was also indicated by high conductivity levels in the stream and signals from the macroinvertebrate community.

2.2.5 Elevated Nutrients

The in-stream levels of total phosphorus and total nitrogen exceeded EPA's recommended nutrient criteria (0.01 mg/l for total phosphorus and 0.38 mg/l for nitrogen) for all base flow and storm flow sampling events at stations S312 and S684 during the special study period in the summer of 2003. Measured total nitrogen values ranged from a high of 1.49 mg/l to a low of 0.78 mg/l at station S312, or two to more than three times the criteria. Total phosphorus concentrations ranged from a low of 0.1 mg/l to a high of 0.28 mg/l for station S312, or 10 to 28 times the criteria. Sources for phosphorus and nitrogen are normally associated with sediments carried by run off water during precipitation events and may be derived from animal waste, wildlife, fertilizers, phosphorus containing organic compounds or simply atmospheric deposition. Nitrogen readily dissolves in water, and is therefore highly mobile in both surface and groundwater and may enter the system via rainfall and snow melt. The effect of these nutrients is to promote the excessive growth of algae in the stream system. The respiration and ultimate decay of these algae and other aquatic plants causes a further depression in dissolved oxygen levels.

2.2.6 Erosion

Maine DEP recently identified eroded soil as the number one pollutant in the state. Erosion and subsequent deposition of eroded material in waterways, affects streams in several ways. Among these are physical changes in stream morphology (e.g. channel size, dimensions, substrate embedding, and bank stabilization). Eroded soil also carries other pollutants including nutrients that contribute to further stresses to aquatic communities and promote excess algae.

2.2.7 Total Suspended Solids – TSS

TSS is a component of storm water run-off. It is a direct result of the erosion caused by surface water moving across the soil surface, a road where sand has been applied in winter, or dust settling on an impervious surface. Sources of TSS are difficult to control and require both structural and non-structural BMPs.

2.3 TOTAL MAXIMUM DAILY LOAD (TMDL) STUDY

The Birch Stream TMDL was approved by EPA in 2006, but relied largely on data collected prior to 2004. Water quality monitoring of the system has been ongoing, with several studies undertaken, and pollution reduction technologies constructed since the completion of the TMDL.

The ongoing water quality monitoring in Birch Stream over the last several years is not temporally and spatially contiguous. As an example, dissolved oxygen (DO) and temperature data were not collected at the same time as stream flow data and data in general is not contiguous in time. MPDES permits are not currently in sync with one another. The gaps in monitoring data make it impossible to develop meaningful correlations between stream flow, precipitation, pollutant load, and water quality.

No clear cause and effect can be defined; rather these are inferred by the presence of the pollutants and the non-attainment of the macroinvertebrate (aquatic bug) community of the Class B Water Quality criteria.

The success of the management actions proposed in this document will be determined by ambient water quality data rather than attainment of TMDL reduction targets (8% impervious cover). For this reason, the City has undertaken the physical and chemical monitoring in Birch Stream as well as other impaired waters under its jurisdiction. The City will work with MDEP to revise this plan as necessary should monitoring substantiate any necessary changes or refinements.

2.4 POLLUTANT LOADING

MDEP includes the following information in its TMDL Report for Birch Stream with regard to pollutant loading. "Non-attainment of water quality criteria in Birch Stream suggests that this stream has exceeded its loading capacity, namely the mass of pollutants a waterbody can receive over time and still meet water quality targets. The Stressor Identification (SI) analysis indicated that urban stressors have caused the impairment in the macroinvertebrate community and the failure to attain aquatic life criteria." "Urban stressors" is a catch-all term encompassing a wide variety of effects caused by urbanization, with the majority of the effects being related, directly or indirectly, to stormwater runoff from impervious surfaces.

Because of the major effect stormwater runoff has on aquatic systems (CWP 2003), the "Impervious Cover Method" (IC method), as employed by ENSR in a pilot TMDL (ENSR 2004), is used in the TMDL report to estimate current and to develop target annual runoff volumes and annual pollutant loads for Birch Stream. The target of 8% IC is a surrogate for actual pollutant load reduction targets which would require much more sampling and analysis. Parameters used in load estimates are annual runoff, annual rainfall, pollutant concentration in runoff (event mean concentrations), and watershed area. The target 8% IC was determined in accordance with MDEP guidance (MDEP 2005) using MDEP data, information from the literature, and local conditions."1 This determination does not include exceptions for areas that may already have stormwater treatment in place, thereby making the target of 8% IC a conservative goal.

The report makes note that removal of impervious areas is not the only way to meet the target 8% IC. Other ways to meet the 8% IC target are by installing stormwater treatment systems or removing sources of pollutants and reducing volume of runoff through infiltration, therefore creating discharge similar in character to an area of 8% impervious cover. This plan utilizes this approach rather than tearing up pavement and dismantling buildings, it seeks to affectively mimic 8% IC through the use of stormwater treatment, infiltration, pollution prevention, pollution removal, and volume reduction.

1 Total Maximum Daily Load Report , Susanne Meidel, **Partnership for Environmental Technology Education (PETE)** and **Maine Department of Environmental Protection** September 09, 2007, Report # DEPLW0715.

3.0 Plan Implementation

3.1 PLAN OWNERSHIP, ADOPTION, AND IMPLEMENTATION

The City, with the assistance of MDEP, initiated the development of this watershed management plan in August 2005. The planning process involved review of existing water quality data, developing a plan to gather much needed hydrology data, and soliciting and incorporating input from citizens, conservation organizations, state agencies, landowners, and business owners.

The plan will be presented to the City Council after MDEP has commented on it, at which time the Council will consider its adoption. Assuming Council approval, the City will exercise a good faith effort to see that the recommendations are enacted in a timely manner.

Implementation of this plan has already begun as retrofits have been installed at BIA, Fleet Maintenance, and the Department of Public Services (Public Works). It is anticipated that one or more retrofits will be initiated within one year after the plan is officially adopted. The plan may take up to 15 or 20 years to implement in its entirety. Successful implementation is dependent upon several variables including landowner cooperation, funding availability, agency cooperation, and administrative coordination. Implementation is also dependent upon achieving Class B standards. If Class B standards are met before implementation is complete, the City may choose to discontinue implementation since the goal of the plan (to meet Class B standards) will have been met.

3.2 IMPLEMENTATION TIMING

The plan recommends numerous tasks in four different pollution-reduction categories including education and prevention, stream restoration, retrofitting existing stormwater structures, and government administration. While Sections 4 through 7 provide detailed information on each of the tasks sorted by pollution-reduction category, Appendix A provides an "Integrated List" of all tasks sorted by 5-year time intervals. The Integrated Table is designed to guide overall implementation of tasks from all categories and illustrates how tasks and projects from various categories may be implemented simultaneously. It is anticipated that retrofits will be implemented as appropriate (from the list or developed by private consultants) as facilities make improvements or maintenance projects are planned. City staff will encourage and assist with implementation of appropriate retrofits as new permits are submitted to the City.

3.3 PARTNERS

The success of this plan will depend not only on the efforts and administration of the City but also on its stakeholders and partners in implementation. Although the City will take the lead in ensuring that the recommendations and tasks are initiated, partnering organizations, state agencies, and private landowners may have responsibility for actually completing some tasks. For example, the City may initiate a small business hazardous materials pick up program, but it will be up to the individual businesses to actually implement and complete the task of coordinating the pick up and

arranging for a disposal contract. Partnering organizations are listed in each set of recommendations in order to facilitate such partnering.

3.4 POTENTIAL FUNDING SOURCES

Initial funding for many project activities is being funded by the ARRA of 2009. The City was awarded nearly two million dollars for existing, "shovel-ready" projects in the Birch Stream Watershed. These included several remedial activities listed in Appendix A of this report. These activities were previously designed by SMRT consultants and closely matched the criteria for funding of the Stimulus Act.

Additional future funding will undoubtedly need to come from the City, MDEP, the Federal Government, and the local business community. BIA receives Federal dollars for airport improvement projects each year. The Maine Air National Guard and the MEARNG may be able to access and allocate federal Department of Defense funding for activities on or near their base.

Maine Stormwater Rules, Chapter 500, requires new development in impaired watersheds to pay a fee in proportion to the amount of runoff they will produce as a result of the development. This fee goes into a Compensation Fund which is managed by the City and used for projects that will benefit the watershed.

The City is currently conducting a feasibility analysis to determine if a City-wide Stormwater Fee would make sense to implement and whether or not the public would be accepting of such a funding mechanism. The feasibility analysis is expected to be completed in 2011.

Additional funding sources may include the following:

State

- Maine Forest Stewardship Program
- Maine Small Business Environmental Assistance Fund Loan Program?
- Maine Resource Authority
- Water Quality Improvement Fund
- Clean Water Act Revolving Loan Program
- Tax Increment Financing
- Supplemental Environmental Projects
- Wetland or Resource Protection Mitigation Actions

Federal

- EPA 319 Funds
- USDA Watershed and River Basin Planning and Installation Public Law 83-566 (PL566)
- US Fish and Wildlife Service Private Stewardship Program
- US Fish and Wildlife Service Conservation Grants
- American Resource and Recovery Act of 2009

Private

- Landowner Contributions
- Private Foundations, Non-Profit Organizations
- Local Businesses Contributions

3.5 FURTHER STUDIES

To help provide a sound basis for investment in stormwater measures, an appropriate and accurate model should be selected and utilized to evaluate the effectiveness of BMPs prior to their installation. Property owners in the watershed have indicated that any costs incurred should be based upon well documented, scientific, and well understood baseline data, so that, as investment is made, measurable improvements can be directly linked to those costs. Periodic assessment of the stream needs to be conducted in order to monitor the impact of improvement measures. After additional monitoring and assessment has occurred and an appropriate model has been selected and applied to the watershed, the list of recommended BMPs (including the retrofits) may be revised accordingly. This will take place through a collaborative review, and the plan will be amended to include the revised integrated list.

3.6 ANNUAL REVIEW AND ADAPTIVE MANAGEMENT

The City and the Birch Stream Watershed Stakeholders will utilize an adaptive management approach in the implementation of the management actions described within this report. The plan will be reviewed by City staff and stakeholders annually upon the anniversary date of the adoption of this plan. As actions are implemented, water quality data are collected, and new information and technology become available, the City, in consultation with the MDEP, will discontinue actions that are deemed ineffective and add or reprioritize actions that may not be included in this report.

The implementation actions discussed in the forgoing sections will be implemented in four phases as identified in Table 3.0. Phase I actions are those that have already been initiated or should be scheduled for completion within five years. Phase II activities are those that should be planned for implementation within the next ten years. Phase III actions will be expected to be completed within the next 15 years. Phase IV will be expected to be completed within the next 20 years. It may be necessary to reevaluate the plan if significant improvements have not been achieved.

If water quality standards are not being met, a Use Attainability Analysis (UAA) may be initiated to reflect the presence of existing conditions which limit water quality and which are due to uncontrollable sources. It must be emphasized that a UAA is a last resort only to be undertaken after all efforts to treat and control pollutant loading to Birch Stream have been completed and evaluated for effectiveness.

Table 3.0 Phased Implementation Approach

Phase/Timeframe	Focus Area	Sub-watershed	% IC *	Land use types
Phase I/5 yrs	#1	Upper	33%	Airport & Maine Air National Guard
Phase I/5 yrs	#2	Lower	54%	Mall, car wash, restaurants, gas station, driving range
Phase II/10 yrs	#3	East	50%	Two healthcare malls, three fast food restaurants, Army National Guard, Public Works, Fleet Maint.
Phase II/10 yrs	#4	Center	52%	Event center, autopark, office bldgs, fitness center, state service center
Phase III/ 15	#5	West	19%	Residential, undeveloped,

	yrs	athletic fields, school campus

** % IC of the sub-watershed*

4.0 Restoration Toolbox

4.1 RESTORATION TOOLBOX

Once a community becomes aware that they have an impaired stream, they have several options and resources available to them for the purposes of mitigation and restoration. These resources are called the Restoration Toolbox. The term "Restoration Toolbox" is used throughout this report in line with standard practice. It denotes a wide range of activities designed to improve water quality through reducing the amount of pollutants that reach a water body, managing stormwater appropriately, and improving impaired habitat and riparian areas. Sections 4 through 7 provide numerous recommendations from the Restoration Toolbox designed to help business owners, government, conservation organizations, and citizenry improve the stream. Where appropriate, each set of recommendations also includes an estimated cost, list of partners needed to complete the task, an assigned authority, potential funding sources, and timeframe.

This plan provides recommendations in the following categories:

- Education (Section 4)
- Prevention and Housekeeping (Section 4)
- Channel and Riparian Restoration (Section 5)
- Retrofitting Existing Facilities (Section 6)
- Administration and Ordinances (Section 7)

4.2 BEST MANAGEMENT PRACTICES (BMP)

All of the recommendations suggested in this plan are considered BMPs. A BMP is a structure or practice designed to minimize the discharge of pollutants that can be carried away by stormwater; or to temporarily store or treat urban stormwater runoff to reduce flooding, remove pollutants, and otherwise mitigate the effects of runoff. For more information about recommended BMPs, please refer to the DEP Stormwater Management for Maine Manual (2006) at the DEP website: http://www.maine.gov/dep/blwq/docstand/stormwater/stormwaterbmps/index.htm

4.3 EDUCATION AND AWARENESS

Perhaps the most effective BMP in the Restoration Toolbox is education and awareness. Table 4.1 lists several recommendations with estimated costs, timeframes, and potential partners and funding sources. The overall goal of the education recommendations is to reduce pollutant loads and stormwater runoff by increasing the public's understanding of influences on the water quality of the stream. The recommendations in Table 4.1 are categorized into three objectives designed to meet this goal:

1. Increase public awareness about the stream and watershed
2. Increase knowledge and awareness about the impacts of NPS pollution and stormwater runoff in urban areas.
3. Increase public engagement in watershed issues and improving stream health.

The City can work together with local businesses, county and state agencies (such as Penobscot County Soil and Water Conservation District and University of Maine and Penobscot County Cooperative Extension), and conservation groups (such as Bangor Land Trust, and the local Audubon Chapter) can work together to conduct these activities. They can be started at any time, can occur simultaneously, and are generally low cost. Education and outreach activities can significantly change human behaviors and daily practices, resulting in reduction of stormwater runoff pollution. The Center for Watershed Protection Watershed Stewardship program provides some guidance on education, advocacy, and prevention. http://www.cwp.org/Resource_Library/Restoration_and_Watershed_Stewardship .

Table 4.1 - Education & Awareness Recommendations

CITY-WIDE EDUCATION & AWARENESS RECOMMENDATIONS						
GOAL: Reduce pollutant loading and stormwater runoff.						
	Task	**Partners** (Who can the City rely upon for help?)	**Authority** (Who will initiate or oversee?)	**Cost** (One time unless noted otherwise)	**Funding**	**Timeframe**
4.1.0	**Public Awareness**					
	OBJECTIVE: Increase public awareness about the stream and watershed					
4.1.1	Install interpretive signs at sites where BMPs are being installed. These can be on public lands or on private with landowner cooperation.	Penobscot SWCD, Chamber of Commerce, Cooperative Extension,	City	$500-$1,000/per site	City, Business Owners, Grants	2011
4.1.2	Develop a "Yardscapes" Demonstration site similar to the Back Cove site in Portland which showcases ecological landscaping with low-maintenance plants http://www.yardscaping.org/demo/portland.htm	Business owners, Chamber of Commerce, Cooperative Extension Service, Conserv. Orgn.	City	25,000	City, Business Owners, Grants	2012
4.2.0	**Education**					
	OBJECTIVE: Increase knowledge and awareness about the impacts of NPS pollution and stormwater runoff in urban areas.					

4.2.1	Initiate a commercial and residential BMP education program that encourages better housekeeping and management of:	Chamber of Commerce, Cooperative Extension, Bangor Area SW Group	City	$5,000	City, Business Owners, Grants	2012
	a. Sand/salt					
	b. Fertilizer and pesticide					
	c. Litter					
	d. Dumpster s					
	e. Hazardous materials					
4.2.2	Increase awareness of source pollution prevention strategies with a media campaign that includes:	Chamber of Commerce, Cooperative Extension,	City	$5,000	City, Business Owners, Grants	2012
	a. Newspaper ads and press releases					
	b. Radio ads					
	c. Outreach through schools and community events					
4.3.0	**Public Engagement**					
	OBJECTIVE: Increase public engagement in watershed issues and improving stream health.					
4.3.1	Work with MEANG, Penobscot Job Corps, etc. to create an annual public event that will conduct water quality monitoring, through bio-surveys or other similar event.	Chamber of Commerce, Cooperative Extension,	City	$7,000 start up $3,500 ongoing -	City, Business Owners, Grants	In Progress
4.3.2	Develop an "Adopt a Stream" program whereby businesses adopt their portion of the stream and/or streets that drain to the stream and are responsible for trash clean	Chamber of Commerce, Business Owners, Conservation Organizations	Chamber of Commerce	$5,000	City, Business Owners,	2012

	up and riparian integrity.				Grants	
4.3.3	Establish the "Business Friends" incentive program that encourages the use of Best Management Practices, and provides public acknowledgement for implementation of such programs.	Chamber of Commerce, Cooperative Extension,	City	$5,000	City, Business Owners, Grants	In Progress
4.3.4	Work with state to require automobile undercarriage cleaning once per year prior to safety inspection in order to reduce leakage of automobile fluids in area parking lots.	State Department of Motor Vehicles. State Legislature	City Chamber of Commerce	0	Not Applicable	2011

4.4 POLLUTION PREVENTION AND HOUSEKEEPING

The overall goal of pollution prevention and housekeeping measures is to prevent the release of pollutants so that they are not available for mobilization by runoff. Table 4.2 lists recommendations designed to achieve this goal using objectives that address seven specific areas:

1. Ensure that sand/salt is properly stored and applied in minimum quantities to avoid excess use and runoff.
2. Ensure that streets and parking lots are free of excess sand and salt.
3. Ensure that structural BMPs are properly designed and maintained so that they function properly (this is also required by the MS4 permit and addressed through the City's post construction ordinance).
4. Reduce the amount of fertilizers and pesticides used in the watershed.
5. Reduce the amount of hazardous materials used in the watershed.
6. Reduce the amount of litter (and associated pollutants) getting into the stream.

Like the education and awareness recommendations, the prevention recommendations can be implemented at any time, can occur simultaneously, and can be completed by a variety of stakeholders in the watershed including individual landowners. This plan and it's recommend evaluations will be reviewed annually by a meeting of stakeholders and staff and a citizen review committee. A summary report of this annual review will be made available on the City's website.

Table 4.2 Birch Stream Prevention and Housekeeping Recommendations

BIRCH STREAM PREVENTION RECOMMENDATIONS						
GOAL: Prevent the release of pollutants in stormwater runoff.						
	Task	**Partners (Who can the City rely upon for help?)**	**Authority** (Who will initiate or oversee?)	**Cost** (One time cost unless noted otherwise)	**Funding**	**Timeframe**
4.2.1	**Sand/salt Management**					
	OBJECTIVE: Ensure that sand/salt is properly stored and applied to avoid excess use and runoff					
4.2.2	Ensure that all sand/salt storage areas comply with DEP requirements. Evaluate need for additional local regulations.	DEP, City, Landowner, Contractors	DEP, CEO	N/A	Landowner/ Business owner	Ongoing
4.2.3	Conduct annual inventory of all sand/salt storage areas.	City, Business Owners	City	$1,000/per year	City	2011
4.2.4	Develop and conduct a sand/salt management education and training program (similar to other DEP contractor training) based on the DEP Stormwater Management BMPs. Program would include:	City, DEP, Landowners, Chamber of Commerce, Contractors	DEP, City	$5,000	DEP	2010
	a. Developing an area s/s contractors list					
	b. Contractor training with certification					
	c. Evaluate need for sand/salt applicators' certification.					

4.2.5	Implement salt use best management practices recommended by BASWG (See Ordinance Recommendations)	City, DEP	City	N/A	N/A	2011
4.2.6	Work with commercial entities to develop a program to direct contaminated rinse water to sanitary sewers.	City, Business Owners	City	$1,000	Business Owners	In progress
4.2.7	**Street Sweeping**					
	OBJECTIVE: Ensure that streets and parking lots are free of excess sand, salt, and other fine particles.					
4.2.8	Sweep major arterial streets twice per month especially prior to storm events when possible (during mid-winter thaws, etc).	City	City	$150,000	City	2011
4.2.9	Work with business owners to ensure that private parking lots are cleaned regularly.	City, DEP, Business owners, Chamber of Commerce	City, Business Owners	$1,000-$5,000 per lot	Business Owners	2011
4.2.10	**Long-term BMP Maintenance**					
	OBJECTIVE: Ensure that structural BMPs are functioning properly.					
4.2.11	Purchase two catch basin cleaning trucks and increase catch basin cleaning crews to full time during spring – fall.	City, DEP, Federal incentives	City	$500,000/ 100,000 annual cost	City	2011/2013
4.2.12	Ensure that all structural BMPs are easy to access, inspected annually, and maintained by certified erosion/stormwater control specialists in accordance with ordinance.	City, DEP, Business owners, Chamber of Commerce	City, Business Owners	N/A	N/A	In progress
4.2.13	Ensure that those structural BMPS of unknown ownership ("orphaned") are maintained.	City, DEP, Business owners, Chamber of	City, Business Owners	N/A	City	Ongoing

		Commerce				
4.2.14	**Fertilizer and Pesticide Management**					
	OBJECTIVE: Reduce the amount of fertilizers and pesticides used in the watershed.					
4.2.15	Initiate a program that works with businesses and neighborhoods based on Board of Pesticide Control's "Best Management Practices for the Application of Turf Pesticides and Fertilizers" (www.maine.gov/agriculture/pesticides/turf_bmps/index.htm). (See Education Recommendations) The program should encourage:	City, DEP, Business owners, Chamber of Commerce, Conservation Organizations	City, Chamber, Business Owners	$2,000	City, Business Owners, Grants	On going
	a. Soil testing prior to application of chemicals					
	b. Limiting the use of pesticides/fertilizers					
	c. Use of phosphorous free, fertilizers					
	d. Planting low maintenance native species					
	e. Integrated Pest Management					
4.2.16	Evaluate need for education and/or certification program for commercial and institutional facilities managers.	City, DEP, Business owners, Chamber of Commerce, Conservation Organizations	City, Chamber, Business Owners	$5,000	City, Business Owners, Grants	2011
4.2.17	**Litter Management**					

	OBJECTIVE: Reduce the amount of litter (and associated pollutants) entering into the stream.					
4.2.18	Evaluate the need to install more trash receptacles in business parking lots (receptacles can be placed in association with cart corrals, medians, etc)	Chamber of Commerce, Keep Bangor Beautiful, City, Business Owners, Conservation Organizations	Chamber of Commerce	N/A	Business Owners	2011
4.2.19	Evaluate the need to amend the dumpster/trash ordinances governing dumpster maintenance whereby businesses regularly inspect and conduct maintenance on dumpsters on their property. (See Ordinance Recommendations)	Chamber of Commerce, Keep Bangor Beautiful, City, Business Owners, Conservation Organizations	Chamber of Commerce	N/A	Business Owners	2011

5.0 Restoration Toolbox: Channel & Riparian Restoration

There are several opportunities for repair, enhancement, and stabilization of the natural portion of Birch Stream. A Geomorphologist will be consulted prior to designing final solutions and developing plans for installation, however, the following paragraphs and table offer some potential solutions.

A few hundred feet downstream of the Airport Mall parking lot is an abrupt bend in the stream, as shown in the photo to the left. At these corners, water flows faster around the outside of the curve and becomes more erosive. Eventually, the stream will work its way through and create an oxbow. This area should be regraded to allow the stream's path to be more direct, and reduce erosion. Part way around the first bend is a dam made up of stones and debris which should also be removed. Maintaining clear flow paths is important to help reduce erosion of the stream banks.

Many portions of the bank of Birch Stream have erosion due to high peak flow experienced in the stream. The bare soil is quite erodable and, as a result, the banks have become undercut in some areas. The images below were taken from behind the Airport Mall looking downstream. When these photos were taken in August 2008, flow was relatively low making undercut areas on the left bank more evident.

More significant bank erosion is evident downstream of the Ohio Street bridge. In this area seen to the right, the sandy bank has been severely undercut in several areas. The failure of the bank is also evidenced by the trees which have fallen in, and now clutter, the stream. This clutter leads to additional erosion as high flows are forced to divert around the obstructions. The stream bed is ledge which slopes toward the eroding bank directing all flows in that direction.

Soil eroded from these areas is being deposited farther downstream at quieter sections of the stream. This ongoing process of erosion and subsequent deposition stresses, and in some cases, eliminates valuable downstream aquatic habitat.

Low stream banks should be stabilized by creating a less steep slope in the undercut areas, preferably 3:1 or flatter, and the same done within the re-channelized section. Re-vegetation should be undertaken using an erosion control mesh, seed and live staking techniques using willow stakes. This combination will stabilize the bank and help prevent any further erosion of the stream while maintaining the natural appearance. Additionally, this measure is effective at providing for some shading and temperature control for the stream.

Along taller bank cuts, it is impractical to slope back the shoreline. These areas should be stabilized with rock-filled gabion baskets.

Another necessary retrofit involves a 30-in Reinforced Concrete Pipe storm water outfall located upstream of Ohio Street which has failed. (See adjacent picture.) This failure is likely due to erosion undercutting the soil under the last segment of pipe. This unattached section of pipe should be removed and the outfall stabilized with riprap. The riprap should extend from under the edge of the culvert all the way to the stream. If possible, the angle at which this pipe enters the stream should be reduced. Currently it is perpendicular to the bank or 90 degrees. A reduced angle entering the stream in line with its flow is more desirable.

Specific site designs will need to be developed before the City and its stakeholders can make implementation decisions. One of the leading agencies in the implementation process is the USDA Natural Resource Conservation Service and the Penobscot County Soil and water Conservation District. They have provided the following estimates for site design and cost estimation (C. Brewer, Penobscot SWCD, Personal Communication, December, 2007):

- 12"-24" culverts = $20.68/ft installed
- 36"-48" culverts = $83/ft installed.
- Streambank Protection = $5.13/lft
- Stream habitat improvement = $50/ft
- Stream Rehabilitation simple structures = $75/ea
- Stream Rehabilitation complex structures = $3,750/ea (such as major road/train crossings)

Table 5.0 - In-Stream Restoration Recommendations

BIRCH STREAM RIPARIAN RESTORATION RECOMMENDATIONS					
GOAL: Restore ecosystem integrity of riparian areas and functionality of stream channel.					
	Site	**Partners** (Who can work together?)	**Authority** (Who will oversee?)	**Funding**	**Timeframe**
5.1.0	**Behind Airport Mall**				
5.1.1	Remove the abrupt bend in the stream, by regrading to allow the stream's path to be more direct and reduce erosion.	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City DEP (NRPA)	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2011
5.1.2	Add native deciduous plantings to moderate stream temperature, create habitat, and stabilize banks.	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City, Landowners	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2012
5.1.3	Part way around the first bend is a dam made up of stones and debris which should be removed.	City, Landowners, Scouts, Conservation Groups, Cooperative Extension, PCS&WCD	City, Landowners	Habitat Restoration	2011
5.2.0	**Griffin Rd. Culvert**				
5.2.1	Replace 30-in reinforced concrete pipe located upstream of Ohio Street which has failed. Remove unattached section of pipe and stabilize outfall with riprap.	City	City	City	2012

5.2.0	**Below Ohio Street**				
5.2.1	Low stream banks should be stabilized by creating a less steep slope in the undercut areas, preferably 3:1 or flatter, and the same done within the re-channelized section	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2014 – 2019
5.2.2	Re-vegetation should be done using an erosion control mesh, seed and live staking techniques using willow stakes.	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2014 - 2019
5.2.3	Along taller bank cuts, it is impractical to slope back the shoreline. These areas should be stabilized with rock-filled gabion baskets.	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2014 - 2019
5.2.4	Improve geomorphic diversity through the creation of riffles for improved DO	City, Landowners, Scouts, Conservation Groups, Cooperative Extension, PCS&WCD, NRSC	City	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2014-2019

SEWALL
JAMES W. SEWALL COMPANY / Since 1880

6.0 Restoration Toolbox: Engineered Treatment Systems (Retrofits)

6.1 ENGINEERED RETROFITS

In recent decades, much has been learned about the impacts of development and the overall interconnectedness of storm water systems. Retrofitting existing storm water systems is the easiest way to adapt them to current practices. Older, existing systems are generally well designed to convey the storm water to a discharge point but not to treat the water quality.

Engineered treatment systems are designed to remove pollutants, cool runoff, provide channel protection and control flooding for a treatment area. To remove the pollutants effectively, removal of the fine soil particles that attach themselves to metals and dissolved nutrients is critical. Cooling the runoff before it reaches the waterbody provides protection for temperature sensitive aquatic life. Channel protection and flood control is designed to protect the waterbody from flooding, bank destabilization and resultant sedimentation. This is accomplished by capturing and slowly releasing the runoff from the site.

6.2 DESIGN CONSTRAINTS

A persistent perception by property owners of previously developed properties is that "when the property was developed it met all applicable standards, and is therefore grand-fathered." This misperception requires that landowners be educated in the new standards and regulatory issues which are the drivers behind current stormwater management in the watershed.

As has been noted in previous sections the simplest retrofits consist of installing filters or detention systems near where the storm water currently collects, then reconnecting the discharge from the filter or detention system to the pre-existing system. Additionally, elimination of impervious areas where it is not needed eliminates runoff that necessitates installation of BMPs. These two approaches comprise the most effective means to improve the water quality.

Inevitably some sites will have design constraints that require careful planning for the use of Low Impact Development techniques. For example, some sites will require infiltration which may be constrained due to the clay soils found throughout the City and due to frozen ground from December through April.

The following stormwater treatment systems are proposed to remove pollutants, cool the runoff, provide channel protection and control flooding for the treatment area. To remove pollutants, the fine particles that trap metals and nutrients must be intercepted and removed. There are several different BMPs designed to accomplish these water quality and quantity goals.

6.3 PRIORITIZING PROPOSED RETROFITS

In general, sub-watersheds have been prioritized due to their intensity of use (% impervious cover) and their proximity to the stream. Retrofits were chosen based upon the most cost effective at removing pollutant loads, proximity to the stream, and intensity of use of the site. Once a proposed BMP is determined, the associated pollutant load removal and cost per acre treated can be established. The BMPs with the least cost per acre treated plus the greatest pollutant load removal were placed highest on the list of priorities.

The most significant constraint to implementation of the Watershed Management Plan is the availability of funding for BMP construction. The most opportune time to undertake such structural changes is when the property owner already plans to do maintenance, modernization, or re-construction of their facilities. No matter where a site ends up on the list of priorities, it could be placed higher on the priority list if a property owner wishes to begin planning for upgrades that could include the retrofits recommended for that site, and therefore lower the overall cost of the retrofits.

The following descriptions provide an outline of proposed engineered BMPs for the Birch Stream Watershed in order of priority. A summary table of the proposed retrofits follows the descriptions.

6.3.1 Upper Sub-watershed Proposed BMP Retrofits

Several retrofits were recently been designed by SMRT, Inc., with grant money from the 319 Program administered by DEP. These retrofits were designed to manage runoff from the Upper sub-watershed properties, the majority of which is made up of airport operations properties. These BMPs address not only high peak flows, and temperature as a result of high volumes, but also remove propylene glycol, petroleum products, sediment, and other toxics and nutrients from the system with newer technologies such as constructed sub-surface wetlands and wind-powered aeration systems. The majority of the recommendations in the SMRT report are being implemented with funds from the American Recovery and Reinvestment Act (ARRA) of 2009, as this plan is being written. These recommendations are considered part of phase I and phase II of this plan.

The Maine Air National Guard portions of this sub-watershed are mostly addressed by the new retrofits installed at the Bangor International Airport. One retrofit that has not been installed through ARRA funds is being considered for funding by MEANG to be installed as designed. It is expected that MEANG will be funding this retrofit which also drains a portion of the Randolph Street neighborhood.

The Maine Army National Guard portion of this sub-watershed already has two existing soil filter systems treating a portion of their operations. These systems are sized properly and are functioning as expected. An additional Stormtech system is being recommended to treat the remainder of the site which is largely impervious. The recommended system is designed to treat water quality, quantity, control temperature, and provide channel protection. It is anticipated that finances will be secured in order to install the recommended treatment systems (or other designs meeting the same WQ pollutant load removal results) within five years of the approval of this plan. This will be considered part of Phase I of this plan. Details are provided in Table 6.0 below.

6.3.2 Lower Sub-watershed Proposed Retrofits

This site is a high priority since there is currently no treatment in place, and runoff drains directly to the Birch Stream, and there is a high volume of vehicular traffic. A cursory evaluation of the impervious cover resulted in 54% impervious. Located at the intersection of Union Street and Griffin Rd., the majority of the site is owned and operated by owners of the mall. The BMPs recommended for this area were designed to treat water quality, quantity, control temperature, and provide channel protection. The City has reviewed and discussed the design concepts with the property owners, and they have assured the City that they are supportive of the concept of adding stormwater treatment to the facility as funding permits. It is anticipated that finances will be secured in order to assist in installing the recommended treatment systems (or other designs meeting the same WQ pollutant load removal results) within five years of the approval of this plan. This will be considered part of Phase I of this plan.

The proposed design concepts (retrofits) for the Lower Sub-watershed are divided into five different focus areas. They are included in Table 6.0 below and are described in detail by focus area in Appendix B.

6.3.3 East Sub-watershed Proposed Retrofits

This area consists of two healthcare malls and several commercial and retail entities. It is approximately 50% impervious, and has a high volume of vehicular traffic movement. Some of the sites in this area already meet state standards for stormwater treatment. For example, the Eastern Maine Healthcare Mall has implemented a combination of detention ponds, wet ponds and bio-retention cells on the property to treat stormwater before it reaches the Union Street catch basin system.

A concept design was developed for the University College Campus and surrounding buildings that form a sub-drainage area. The concept design was part of the report by SMRT completed in January 2009. The design concept is a simple bio-filtration system that will enhance the view of the campus from Maine Avenue.

As part of this plan, retrofit recommendations have been developed by Sewall Co. for the other large health care plaza in this area. The retrofits were designed to treat water quality, quantity, control temperature, and provide channel protection. The City has discussed retrofit recommendations with the property owners and facility managers, and they have assured the City that they are supportive of the concept of adding stormwater treatment to the facility as funding permits. It is anticipated that finances will be secured in order to assist in installing the recommended treatment systems (or other designs meeting the same WQ pollutant load removal results) within ten years of the approval of this plan. This will be considered part of Phase II of this plan (see Table 6.0).

6.3.4 Center Sub-watershed Proposed Retrofits

This area includes several office buildings, an auto park, a fitness center, and other businesses that have a medium level of vehicular traffic. The area is approximately 52% impervious, and currently has no treatment, with many individual sites contributing runoff directly to the stream.

All of these factors together make this sub-watershed equal in priority to the East Sub-watershed. Sites in this sub-watershed that have no treatment will be expected to install systems that treat run-off in a similar manner. As part of this plan, retrofits have been designed for priority properties located on Griffin Rd between Maine Avenue and Union Street. The retrofits were designed to treat water quality, provide temperature control and provide some channel protection. It is anticipated that finances will be secured in order to assist in the installation of the recommended treatment systems (or other designs meeting the same WQ pollutant load removal results) a within ten years of the approval of this plan. This will be considered part of Phase II of this plan (see Table 6.0).

6.3.5 West Sub-watershed Proposed Retrofits

This sub-watershed consists mostly of residential properties, athletic fields and the Penobscot Job Corps Academy Campus. Several apartment and condominium buildings exist on properties that abut the natural stream segment. Some newer housing units have properly designed storm water measures that conform to current state water quality and quantity standards including wet ponds with submerged outlets and properly sized vegetated buffers. Residences in well established neighborhoods will be encouraged and supported in order to disconnect roof and driveway run-off from stormwater conveyances using gutters, downspouts, rain barrels, rain gardens and porous pavers. The Penobscot Job Corps Academy campus and all other multi-family residential facilities will be expected to develop a plan for disconnecting roof and parking lot run-off from the stormwater system utilizing bio-filtration or similar systems. In accordance with the adaptive management approach, if the stream has met water quality standards by this time, then this phase will be optional and may not need to be implemented. If implementation is deemed necessary, then it is anticipated that plans will be developed and finances will be secured in order to assist in the installation of recommended treatment systems. Those plans have not and should not be developed until such time as they are deemed necessary. Therefore, no figures are included in the table for this sub-watershed under phase III. If phase III is deemed necessary than it will be scheduled for completion within 15 years of adoption of this plan (see Table 6.0).

6.3.6 Union Street and other Areas of Concern

The road surface, shoulder, and right of way along Union Street represents another set of potential opportunities to remove pollutants, and provide channel protection. The City will need to work with Maine Department of Transportation to develop retrofits to help capture salts, sediment, and other pollutants from this highly traveled street. Union Street is included in phase II of the implementation schedule, but plans have not been developed, therefore costs are estimated, based upon average cost of retrofits already implemented.

6.3.7 Remaining Areas to be Retrofitted

In accordance with the adaptive management approach, if water quality standards have not been met by end of phase III of this implementation schedule, a re-evaluation of the program should be considered. It may be determined that remaining properties that do not have updated treatment systems should be identified and targeted for implementation. If implementation is deemed necessary, then it is anticipated that plans will be developed and

finances will be secured in order to assist in the installation of recommended treatment systems. This will be considered phase IV of this plan and should be completed within 20 years (see Table 6.0).

Table 6 - Birch Stream Retrofit BMP Recommendations

Upper Sub-watershed/ Site name	Total Area (Ac)	Impervious Area (Ac)	Cost/Retrofit	Cost/ Ac Imp Area	Est. Pollutant Load (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (%)	Planned Timeframe Phase I
International Canal System Upgrade & Aeration	543.8	201*	$690,503	$3.6K	301	211	70%	2010
Subsurface Wetland Treatment	Included with above	Included with above	Included with above	Included with above	--	--	70%	2010
Domestic Canal Channel Improve	389.6	144	$928,604	$10K	216	151	70%	2010
Reform Wet Pond to Dry	Included with above	Included with above	Included with above	Included with above	--	--	70%	2010
Godfrey Boulevard Bio filtration	3.3	1.8	$83,635	$36K	2.7	2.16	70%	2010
Ditch Outlet (Solution #8)MEANG	15	4.5	$120,000	$27K	6.75	4.7	70%	5 years
Pavement removal (Solution #4)	18/72	18/72	$540,000	$25K-$30K	18	18	100	5 years
StormTec Isolater Row – MEARNG	44.3	36	$590,700	$16.4K	54	38	70%	5 years
Bio-retention – MEARNG	12.33	6.36	--	--	9.5	6.67	40%	2009
Total	**1026.33**	**411.66**	**$2,953,442**	**--**	**607.95**	**431.53**	**--**	**--**

Lower Sub-Watershed	Total Area (Ac)	Impervious Area (Ac)	Cost/Retrofit	Cost/ Ac Imp Area	Est. Pollutant Load (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (%)	Planned Timeframe Phase I
StormTec,Filterra, Revegetation @ Maine Ave./Griffin Rd.	42.4	24.38	$478,199	$20K	36	19	77	5 years
Cumulative Total	**1068.73**	**436.04**	**$3,431,641**	**--**	**643.95**	**450.53**	**--**	**5 years**

Center Sub-Watershed	Total Area (Ac)	Impervious Area (Ac)	Cost/Retrofit	Cost/ Ac Imp Area	Est. Pollutant Load (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (%)	Planned Timeframe Phase II
Soil filter systems, Filterras, and buffers @ Maine Ave./Griffin Rd	16	11	$382,300	$35K	14	7	79	5-10 years
Cumulative Total	**1084.73**	**447.04**	**$3,813,941**	**--**	**657.95**	**457.53**	**--**	**10 years**
East Sub-Watershed	**Total Area (Ac)**	**Impervious Area (Ac)**	**Cost/Retrofit**	**Cost/ Ac Imp Area**	**Est. Pollutant Load (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (%)**	**Planned Timeframe Phase II**
Union Street (MDOT)	15.25	7.4	$266,400(?)	$36K	**14.8	10.3	70	5-10 years
Soil filter systems, Filterra, buffers @ Maine Ave./Godfrey Blvd.	10	8	$224,213	$28K	12	8.4	70	5-10 years

Public Works Drainage Pipe Outlet Filters	23	22	$20,000	$2K/acre	**44	26.4	60	2010
University College Site Bio-filtration System[2]	41	15.6	$150,000	$10K	23.4	16.38	70	5-10 years
BIA Pavement removal (Solution #4)	18/54	18/54	$540,000	$25K-$30K	18	18	100	5-10 years
Cumulative Total For 10th year of plan	**1191.98**	**518.04**	**$5,014,554**	**--**	**770.15**	**537.01**	**--**	**10 years**
West Sub-Watershed	**Total Area (Ac)**	**Impervious Area (Ac)**	**Cost/Retrofit**	**Cost/ Ac Imp Area**	**Est. Pollutant Load (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (%)**	**Planned Timeframe Phase III**
Residential areas - gutters, rain barrels/rain gardens, porous pavers	??	??	??	--	--	--	--	10-15 years
Bio-retention systems – commercial properties	??	??	??	--	--	--	--	10-15 years
Buffers on properties along	??	??	??	--	--	--	--	10-15 years

[2] A Concept design for Stormwater treatment for the UCB campus is included in the BIA Concept Design Report, SMRT, Jan. 2009.

strm & tributaries								
Pavement removal (BIA Solution #4)	18/36	18/36	$540,000	$25K-$30K	18	18	100	10-15 years
All Other Areas	**Total Area (Ac)**	**Impervious Area (Ac)**	**Cost/Retrofit**	**Cost/ Ac Imp Area**	**Est. Pollutant Load (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (%)**	**Planned Timeframe Phase IV**
Residential areas - gutters, rain barrels/rain gardens, porous pavers	??	??	??	--	--	--	--	15-20 years
Bio-retent systems @ commercial properties	??	??	??	--	--	--	--	15-20 years
Pavement removal (BIA Solution #4)	18/18	18/18	$540,000	$25K-$30K	18	18	100	15-20 years

** This calculation based upon total areas treated and an average of 37% IC per Edwards & Kelcey Drainage Study, March 2007. **Pollutant load for heavily used traffic areas is estimated at 2 lbs/acre all other priority areas estimated at 1.5 lbs/acre.*

7.0 Restoration Toolbox: Ordinances & Administration

7.1 ORDINANCES

In order to implement the recommendations for education, prevention, restoration, and retrofitting existing stormwater structures, the City will need to:

1. Use a stakeholder process to review proposed ordinance or policy changes that might affect citizens and/or property owners
2. Enact new ordinances which enable the City to conduct implementation,
3. Consider obtaining easements on properties that abut streams where the City would like to install BMPs,
4. Evaluate and possibly amend staff duties where needed, and
5. Review and amend current ordinances to ensure that they address current and future development and stormwater BMP requirements.

Once the plan is adopted, the City will need to consider the ordinance changes necessary to enable implementation. Implementation of structural BMPs may require further and more specific site planning; and the City may need to establish easements or agreements with property owners and collect fees for any future work. Table 7.1 lists the recommended ordinances needed to continue with implementation. The City recognizes that an equitable approach is necessary and will consider applying all new regulations citywide.

7.2 ADMINISTRATION

Given the number of programs and recommendations needed to improve water quality and prevent future NPS pollution, the City may need to consider changing staff duties and/or adding new staff in order to complete the tasks in a timely manner. For example, additional staff may be needed to implement programs, enforce ordinances, design and oversee construction projects, populate and update stormwater models, implement BMPs, and conduct education and outreach programs. Table 7.2 lists the administrative recommendations that will likely be needed to enable implementation to occur. These recommendations will be initiated, enacted, and funded by the City. Funding for administrative changes will most likely come from the City's general funds, unless alternative funding is identified. A discussion of one report for alternative funding sources in section 1.4 Existing Reports.

Table 7.1 - Birch Stream Ordinance Recommendations

BIRCH STREAM ORDINANCE RECOMMENDATIONS		
All of the following recommendations would be initiated and administered by the City.		
	Proposed Ordinance Description	**Timeframe**
7.1.0	**GOAL: Establish ordinances that support the use of best management practices and other stormwater measures in all City watersheds**	
7.1.1	Consider the creation of an ordinance that establishes a Stormwater Utility District in which members of the district pay a pro-rated fee that can be used to pay for the upgrade of existing structural BMPs. (See Retrofit Funding and Incentives).	In Process
7.1.2	Implement established ordinance requiring annual inspection and maintenance of all structural BMPs in accordance with MDEP Stormwater Manual.	In Process
7.1.3	Create a dumpster maintenance ordinance whereby businesses are required to regularly inspect and conduct maintenance on dumpsters on their property. (See Prevention/Housekeeping Recommendations)	2011
7.1.4	Evaluate the need to establish ordinances based on recommended BMPs (see CWP “Better Site Design Handbook") and on the following principles:	2011
	a. Require minimum 75 ft buffers that abut the stream on commercial and residential sites for all new an re- development (Compare with current standards).	
	b. All new and existing buffers should be composed of woody shade-bearing, native tree species.	
	c. Consider banning the use of fertilizers and pesticides in the watershed, at least temporarily.	
	d. Implement salt use restrictions/limits near waterbodies or throughout watershed	
7.2.0	**GOAL: Ensure that current ordinances address current and future development BMP needs**	
7.2.1	Update current impervious cover data and build-out findings to include recent land-use changes and development in order to determine what levels are acceptable and what changes, are necessary for future development levels.	In Process
7.2.2	Systematically review existing codes, standards, and ordinances and compare them to the "model development principles" as established in the "Better Site Design" Handbook at the Center for Watershed Protection	In Process

	(http://www.cwp.org/PublicationStore/bsd.htm).	
7.2.3	Develop a Stormwater Amendment to the City Comprehensive Plan.	2010
7.2.4	Create an incentive program where owners of new developments (which presumably would install modern, less polluting structural BMPs) would provide resources to fund one of the retrofit projects as a mitigation requirement to insure that a new development has no impact on water quality. This method could also be used with re-development of an existing site.	On going

Table 7.2. - Birch Stream Administrative Recommendations

BIRCH STREAM ADMINISTRATIVE RECOMMENDATIONS				
All of the following would be initiated, enacted, and funded by the City.				
	Task	**Partners (Who can the City rely upon for help?)**	**Cost**	**Timeframe**
7.3.0	**GOAL: Ensure that there is sufficient support staff to enact plan.**			
7.3.1	Develop an annual work plan (and publish it to the public) by anniversary date of approved WMP.	Citizen SW Review Panel	$1,000	2011
7.3.2	Hire required staff needed to implement programs, enforce ordinances, oversee construction, implementation of BMPs, and education program.	N/A	$67,000	2012
7.4.0	**GOAL: Ensure that there is sufficient organizational structure to enact plan.**			
7.4.1	Adopt the Birch Stream Watershed Management Plan	Citizen SW Review Panel	N/A	2010
7.4.2	Update the Birch Stream Compensation Fee Utilization Plan and integrate with this management plan.	Citizen SW Review Panel	N/A	2011

7.4.3	Establish a City staff working group that consists of representatives from all relevant City departments that reviews all stormwater, development, and planning related issues. Where appropriate, invite stakeholder involvement.	Citizen SW Review Panel	N/A	2010
7.4.4	Where necessary and appropriate, seek public easements along stream in order to increase opportunities and access for restoration and water quality improvement.	Citizen SW Review Panel	$20,000	Ongoing
7.5.0	**GOAL: Ensure that there is sufficient data and an accurate model to measure change and predict outcomes of investments**	Citizen SW Review Panel	$50,000	2012

8.0 Milestones and Future Monitoring Efforts

8.1 ADAPTIVE MANAGEMENT

The proposed pollutant reduction measures in the Birch Stream watershed will be implemented in phases. Phased implementation, also termed adaptive management, is an iterative process that first addresses those sources with the largest impact on water quality, focusing on those measures and practices that can be accomplished with the resources available. All phases of management actions, will target the controllable, anthropogenic (human induced) sources identified in the stressor analysis, focusing on those areas which contribute the most to the existing water quality impairments. During the implementation of each phase, all controllable sources will be reduced to the maximum extent practicable using an iterative approach and a prioritized list of storm water best management practices. Use of a prioritized list of BMP's and retrofits to choose from provides the necessary flexibility to match water quality improvement technologies to available funding. The phased approach allows for assessment of water quality improvements of these BMP's through monitoring, and to facilitate changes, if necessary, in future actions based upon the information obtained.

MDEP and the City will re-assess water quality based upon data collected by the MDEP, the City, the Army National Guard, the Maine Air National Guard and other sources. Such a re-assessment will occur during and subsequent to the implementation of each phase to determine the effect of the selected actions on water quality.

Phase I improvements are those that have already been initiated or are scheduled for completion within five years. Phase II activities are those that are planned for implementation within the next ten years. Phase III actions should be completed within the next 15 years from the date of adoption of this plan. Phase IV actions will be completed within the next 20 years and include time for the stream to regenerate after remediation activities have occurred (see Table X).

8.2 MEASURABLE MILESTONES

The ultimate measure of success would be for Birch Stream to consistently attain Class B water quality standards over two consecutive sampling events within 10 years (MDEP). At the outset of the restoration process this seems like a lofty goal, but is nevertheless the objective of this work. Establishing interim goals is therefore important to attaining this objective. Following is a breakdown of interim goals:

1) Reduce the volume of runoff during storm events, reducing peak flows to the maximum extent practicable,

2) Eliminate all sources of propylene glycol entering the watershed to the maximum extent practicable,
3) Reduce, to the maximum extent practicable, non-atmospheric sources of nutrients and other pollutants,
4) Reduce, to the maximum extent practicable, thermal impacts to a level where it is no longer a stressor on the macroinvertebrate community,
5) Improve water quality to a sustainable Class C standard for water quality and aquatic life within five years,
6) Improve water quality to a sustainable Class B standard for water quality and aquatic life within twenty years.

The purpose of monitoring milestones is to evaluate the effectiveness of implementation efforts. Specifically, the milestones should measure progress toward implementation of the plan and whether the efforts are achieving load reductions over time and progressing towards attainment of Class B standards. All recommendations in the plan include a timeframe for initiating and, in some cases, completing the tasks. However, it is helpful to view the tasks in terms of milestones. Tables 8.1 through 8.4 include milestones for education and prevention, restoration, structural retrofits, and administration and ordinances that the City will incorporate into its annual review and adaptive management program.

Table 8.1 - Milestones for Education and Prevention

Education and Prevention Milestones **Goal: Have education and prevention programs in place by 2012** **Milestone**
• One demonstration site is established per year for the next 5 years
• Signage is established throughout watershed in the first 3 years
• Business Friends generates 2 new business per year for the next 7 years
• Sand/salt management training is held annually for the first 3 years and biannually for the next 5-10 years
• Education programs are in place within the first 3 years and at least 3 program activities (training, newsletter, haz mat disposal) occur every year as needed.

Table 8.2 - Milestones for In-Stream and Riparian Restoration

In-Stream and Riparian Restoration Milestones **Goal: Restore ecosystem integrity of riparian areas and functionality of stream channel.** **Milestone**
• 1-2 restoration projects implemented per year. Restoration Projects should be completed by year 2020
• Buffers and/or riparian areas restored @ 1 mile per year and be completed by 2020
• Trail and/or interpretative natural area along the stream developed by 2015
• Establish gages to monitor flow before and after restoration

Table 8.3 - Milestones for Retrofitting Structural BMPs

Retrofit Milestones **Goal: Reduce pollutant and sediment loading, cool water temperatures, and reduce stormwater flow by 2025.** **Milestone**
• Phase I – Upper and Lower sub-watershed recommended retrofits to be implemented within in 5 years of adoption of this plan.
• Phase II – East and Central sub-watershed recommended retrofits to be implemented plus enhanced monitoring program within 10 years from date of adoption of this plan.
• Phase III – West sub-watershed retrofits plus Riparian and in-stream recommendations to be implemented within 15 years from date of adoption of this plan.
• Phase IV – Remaining or additional retrofits implemented within 20 years.

Table 8.4 Milestones for Administrative and Ordinance Improvements

Administrative and Ordinance Milestones Goal: Establish ordinances that support the use of best management practices and other stormwater measures in all City watersheds; ensure that current ordinances address current and future development BMP needs; ensure that there is sufficient staff and organizational structure to enact plan.
Milestone
• Annual work plan developed (and published to the public) by anniversary date of approved WMP.
• Organizational structure developed and staff increased by 1 part time person within 1 year.
• City staff working group reviews all stormwater related issues established and review of ordinances is established within 2 years.

8.3 WATER QUALITY MONITORING

It is imperative that future monitoring be done in a coordinated, watershed-wide manner. All aspects of water quality should be addressed concurrently including stream flow, temperature, dissolved oxygen (DO) concentration, conductivity, pH and known point source loading. Other important factors to consider are weather conditions immediately prior to or during sampling efforts.

The most critical factors to monitor are those specified in the water quality standards or identified as potential stressors to the aquatic system. This should include, as a minimum, stream flow rate, dissolved oxygen, nutrients, pH, conductivity, dissolved salts, temperature, bacteria (E. coli) and, if possible, known point source discharges. Monitoring must be undertaken concurrently at several representative points in the watershed to determine to where the major pollutant sources are located.

Beginning in August 2006, stream flow and temperature data has been recorded continuously. These results will be correlated with precipitation events in the watershed to develop a cause and effect relationship between the two. Water quality monitoring for a basic suite of parameters (D.O., pH, conductivity, temperature and chlorides) was begun for all of the City's impaired waters in August of 2009.

Efforts are underway to better coordinate the multiple monitoring efforts that are being undertaken in Birch Stream by state government, the City and MPDES permit holders such as BIA and the MEANG. Coordinated sampling will yield data that can be used to better characterize the stream and the pollutant loads delivered. Such sampling will also greatly facilitate determining BMP performance as they are completed and brought on line. Utilizing this monitoring data in a

modeling program will greatly assist in adaptive decision making with regard to future efforts such that cost effective BMPs are employed in a targeted fashion.

Table 8.5 Milestones for Water Quality Monitoring

Water Quality Monitoring Milestones **Goal: Establish and maintain a regular, continuous monitoring program and achieve Class B standards by 2023.** **Milestone**
• Birch Stream has 5 years of baseline data and is well-established by 2015
• Dissolved oxygen downstream of Maine Avenue is 7 ppm by 2020
• DEP will continue macroinvertebrate monitoring on 5 yr rotation schedule
• City will coordinate annual bio-survey to establish a cursory baseline for macroinvertebrate indicators by 2010
• A model for predicting the affects of new BMPs on the watershed will be chosen, implemented and maintained within 5 yrs
• Sampling data generated by the City, and references to DEP's data will be available on the City's website.

9.0 References

Storm water Management for Maine, Volume III: BMPs Technical Design Manual. Maine Department of Environmental Protection. Document No. DEPLW0738. January 2006.

Bangor International Airport, Storm water Design Services: Final Design Report. SMRT, Inc. Project No. 08178. January 2009. Stamped by Andrew D. Johnson, PE on January 21, 2009.

Urban Streams Non-point Source Assessments in Maine: Final Report. Susanne Meidel, Partnership for Environmental Technology Education (PETE) and Maine Department of Environmental Protection. Document DEPLW0699. February 16, 2005.

Birch Stream Total Maximum Daily Load (TMDL) Report. Susanne Meidel, Partnership for Environmental Technology Education (PETE) and Melissa Evers, Maine Department of Environmental Protection. Report # DEPLW0715. April 13, 2006.

Biodegradability of Organic Substances in the Aquatic Environment. Pavel Pitter and Jan Chudoba.. 1990. CRC Press, Boca Raton, FL.

10.0 Appendices

10.1 APPENDIX A – INTEGRATED LIST OF BEST MANAGEMENT PRACTICES

10.2 APPENDIX B - FOCUS AREA DESCRIPTIONS AND DRAWINGS OF RETROFITS FOR ALL SUB-WATERSHEDS

10.3 APPENDIX C – WATER QUALITY CALCULATIONS FOR PRIORITY SITES

10.4 APPENDIX D - COMPLETE BENTHIC MODELING DATA

SEWALL
JAMES W. SEWALL COMPANY / Since 1880

Appendix A

Integrated list of Best Management Practices

CITY-WIDE EDUCATION & AWARENESS RECOMMENDATIONS						
GOAL: Reduce pollutant loading and stormwater runoff.						
	Task	**Partners** (Who can the City rely upon for help?)	**Authority** (Who will initiate or oversee?)	**Cost** (One time unless noted otherwise)	**Funding**	**Timeframe**
4.1.0	**Public Awareness**					
	OBJECTIVE: Increase public awareness about the stream and watershed					
4.1.1	Install interpretive signs at sites where BMPs are being installed. These can be on public lands or on private with landowner cooperation.	Penobscot SWCD, Chamber of Commerce, Cooperative Extension,	City	$500-$1,000/per site	City, Business Owners, Grants	2011
4.1.2	Develop a "Yardscapes" Demonstration site similar to the Back Cove site in Portland which showcases ecological landscaping with low-maintenance plants http://www.yardscaping.org/demo/portland.htm	Business owners, Chamber of Commerce, Cooperative Extension Service, Conserv. Orgn.	City	25,000	City, Business Owners, Grants	2012
4.2.0	**Education**					

	OBJECTIVE: Increase knowledge and awareness about the impacts of NPS pollution and stormwater runoff in urban areas.					
4.2.1	Initiate a commercial and residential BMP education program that encourages better housekeeping and management of:	Chamber of Commerce, Cooperative Extension, Bangor Area SW Group	City	$5,000	City, Business Owners, Grants	2012
	a. Sand/salt					
	b. Fertilizer and pesticide					
	c. Litter					
	d. Dumpster s					
	e. Hazardous materials					
4.2.2	Increase awareness of source pollution prevention strategies with a media campaign that includes:	Chamber of Commerce, Cooperative Extension,	City	$5,000	City, Business Owners, Grants	2012
	a. Newspaper ads and press releases					
	b. Radio ads					
	c. Outreach through schools and community events					
4.3.0	**Public Engagement**					
	OBJECTIVE: Increase public engagement in watershed issues and improving stream health.					
4.3.1	Work with MEANG, Penobscot Job Corps, etc. to create an annual public event that will conduct water quality monitoring, through bio-surveys or other similar event.	Chamber of Commerce, Cooperative Extension,	City	$7,000 start up $3,500 ongoing -	City, Business Owners,	In Progress

					Grants	
4.3.2	Develop an "Adopt a Stream" program whereby businesses adopt their portion of the stream and/or streets that drain to the stream and are responsible for trash clean up and riparian integrity.	Chamber of Commerce, Business Owners, Conservation Organizations	Chamber of Commerce	$5,000	City, Business Owners, Grants	2012
4.3.3	Establish the "Business Friends" incentive program that encourages the use of Best Management Practices, and provides public acknowledgement for implementation of such programs.	Chamber of Commerce, Cooperative Extension,	City	$5,000	City, Business Owners, Grants	In Progress
4.3.4	Work with state to require automobile undercarriage cleaning once per year prior to safety inspection in order to reduce leakage of automobile fluids in area parking lots.	State Department of Motor Vehicles. State Legislature	City Chamber of Commerce	0	Not Applicable	2011

BIRCH STREAM RIPARIAN RESTORATION RECOMMENDATIONS					
GOAL: Restore ecosystem integrity of riparian areas and functionality of stream channel.					
	Site	**Partners** (Who can work together?)	**Authority** (Who will oversee?)	**Funding**	**Timeframe**
5.1.0	**Behind Airport Mall**				
5.1.1	Remove the abrupt bend in the stream, by regrading to allow the stream's path to be more direct and reduce erosion.	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City DEP (NRPA)	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2011

5.1.2	Add native deciduous plantings to moderate stream temperature, create habitat, and stabilize banks.	City, DEP, Landowners, Engineering Consultants, PCS&WCD, NRCS	City, Landowners	Habitat Restoration Grants (WIFAP, 319, NFWF, USDA, NOAA, USFWS)	2012
5.1.3	Part way around the first bend is a dam made up of stones and debris which should be removed.	City, Landowners, Scouts, Conservation Groups, Cooperative Extension, PCS&WCD	City, Landowners	Habitat Restoration	2011
5.2.0	**Griffin Rd. Culvert**				
5.2.1	Replace 30-in reinforced concrete pipe located upstream of Ohio Street which has failed. Remove unattached section of pipe and stabilize outfall with riprap.	City	City	City	2012

Upper Sub-watershed/ Site name	Total Area (Ac)	Impervious Area (Ac)	Cost/Retrofit	Cost/ Ac Imp Area	Est. Pollutant Load (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (%)	Planned Timeframe
International Canal System Upgrade & Aeration	543.8	201*	$690,500	$3.4K	301	211	70	2010
Subsurface Wetland Treatment	Included with above	Included with above	Included with above	Included with above	--	--	70	2010
Domestic Canal Channel Improve	389.6	144	$928,600	$10K	216	151	70	2010
Reform Wet Pond to Dry	Included with above	Included with above	Included with above	Included with above	--	--	70	2010
Godfrey Boulevard Bio filtration	3.3	1.8	$65,000	$36K	2.7	2.16	70	2010

Ditch Outlet (Solution #8)MEANG	15	4.5	$120,000	$27K	6.75	4.7	70	5 years
Pavement removal (Solution #4)	72	72	$2,160,000	$25K-$30K	72	72	100	5-10 years
StormTec Isolater Row – MEARNG	44.3	36	$590,700	$16.4K	54	38	70	5 years
Bio-retention – MEARNG	12.33	6.36	--	--	9.5	6.67	40	2009
Total	1080.33	465.66	$4,554,800	--	661.95	485.53	--	--
Lower Sub-Watershed	**Total Area (Ac)**	**Impervious Area (Ac)**	**Cost/Retrofit**	**Cost/ Ac Imp Area**	**Est. Pollutant Load (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (%)**	**Planned Timeframe Phase I**
StormTec,Filterra, Revegetation @ Maine Ave./Griffin Rd.	42.4	24.38	$478,199	$20K	36	19	77	5 years
Cumulative Total	**1122.73**	**490.04**	**$5,032,999**	**--**	**697.95**	**504.53**	**--**	**5 years**
Center Sub-Watershed	**Total Area (Ac)**	**Impervious Area (Ac)**	**Cost/Retrofit**	**Cost/ Ac Imp Area**	**Est. Pollutant Load (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (%)**	**Planned Timeframe Phase II**
Soil filter systems, Filterras, and buffers @ Maine Ave./Griffin Rd	**16**	**11**	**$382,300**	**$35K**	**14**	**7**	**79**	**5-10 years**
Cumulative Total	**1138.73**	**501.4**	**$5,415,299**	**--**	**711.95**	**511.53**	**--**	**10 years**

East Sub-Watershed	Total Area (Ac)	Impervious Area (Ac)	Cost/Retrofit	Cost/ Ac Imp Area	Est. Pollutant Load (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (Lbs/yr of TP)	Est. Load Reduction w/Retrofit (%)	Planned Timeframe Phase II
Union Street (MDOT)	15.25	7.4	$266,400(?)	$36K	**14.8	10.3	70	5-10 years
Soil filter systems, Filterra, buffers @ Maine Ave./Godfrey Blvd.	10	8	$224,213	$28K	12	8.4	70	5-10 years
University College Bio-filtration System	22	6.6(?)	$150,000	$23K	9.9	6.93	70	5-10 years
Public Works Drainage Pipe Outlet Filters	23	22	$20,000	$2K/acre	**44	26.4	60	2010
Cumulative Total	1208.98	545.4	$6,075,912	--	792.65	563.56	--	10 years
West Sub-Watershed & All Other Areas	**Total Area (Ac)**	**Impervious Area (Ac)**	**Cost/Retrofit**	**Cost/ Ac Imp Area**	**Est. Pollutant Load (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (Lbs/yr of TP)**	**Est. Load Reduction w/Retrofit (%)**	**Planned Timeframe Phase III**
Residential areas - gutters, rain barrels/rain gardens, porous pavers	??	??	TBD	--	--	--	--	10-15 years
Commercial properties Bio-retention systems & buffers	??	??	TBD	--	--	--	--	10-15 years

BIRCH STREAM ORDINANCE RECOMMENDATIONS		
All of the following recommendations would be initiated and administered by the City.		
	Proposed Ordinance Description	**Timeframe**
7.1.0	**GOAL: Establish ordinances that support the use of best management practices and other stormwater measures in all City watersheds**	
7.1.1	Consider the creation of an ordinance that establishes a Stormwater Utility District in which members of the district pay a pro-rated fee that can be used to pay for the upgrade of existing structural BMPs. (See Retrofit Funding and Incentives).	In Process
7.1.2	Implement established ordinance requiring annual inspection and maintenance of all structural BMPs in accordance with MDEP Stormwater Manual.	In Process
7.1.3	Create a dumpster maintenance ordinance whereby businesses are required to regularly inspect and conduct maintenance on dumpsters on their property. (See Prevention/Housekeeping Recommendations)	2011
7.1.4	Evaluate the need to establish ordinances based on recommended BMPs (see CWP “Better Site Design Handbook") and on the following principles:	2011
	a. Require minimum 75 ft buffers that abut the stream on commercial and residential sites for all new an re- development (Compare with current standards).	
	b. All new and existing buffers should be composed of woody shade-bearing, native tree species.	
	c. Consider banning the use of fertilizers and pesticides in the watershed, at least temporarily.	
	d. Implement salt use restrictions/limits near waterbodies or throughout watershed	
7.2.0	**GOAL: Ensure that current ordinances address current and future development BMP needs**	
7.2.1	Update current impervious cover data and build-out findings to include recent land-use changes and development in order to determine what levels are acceptable and what changes, are necessary for future development levels.	In Process
7.2.2	Systematically review existing codes, standards, and ordinances and compare them to the "model development principles" as established in the "Better Site Design" Handbook at the Center for Watershed Protection (http://www.cwp.org/PublicationStore/bsd.htm).	In Process

7.2.3	Develop a Stormwater Amendment to the City Comprehensive Plan.	2010
7.2.4	Create an incentive program where owners of new developments (which presumably would install modern, less polluting structural BMPs) would provide resources to fund one of the retrofit projects as a mitigation requirement to insure that a new development has no impact on water quality. This method could also be used with re-development of an existing site.	On going

BIRCH STREAM ADMINISTRATIVE RECOMMENDATIONS

All of the following would be initiated, enacted, and funded by the City.

	Task	Partners (Who can the City rely upon for help?)	Cost	Timeframe
7.3.0	**GOAL: Ensure that there is sufficient support staff to enact plan.**			
7.3.1	Develop an annual work plan (and publish it to the public) by anniversary date of approved WMP.	Citizen SW Review Panel	$1,000	2011
7.3.2	Hire required staff needed to implement programs, enforce ordinances, oversee construction, implementation of BMPs, and education program.	N/A	$67,000	2012
7.4.0	**GOAL: Ensure that there is sufficient organizational structure to enact plan.**			
7.4.1	Adopt the Birch Stream Watershed Management Plan	Citizen SW Review Panel	N/A	2010
7.4.2	Update the Birch Stream Compensation Fee Utilization Plan and integrate with this management plan.	Citizen SW Review Panel	N/A	2011
7.4.3	Establish a City staff working group that consists of representatives from all relevant City departments that reviews all stormwater, development, and planning related issues. Where appropriate, invite stakeholder involvement.	Citizen SW Review Panel	N/A	2010

7.4.4	Where necessary and appropriate, seek public easements along stream in order to increase opportunities and access for restoration and water quality improvement.	Citizen SW Review Panel	$20,000	Ongoing
7.5.0	**GOAL: Ensure that there is sufficient data and an accurate model to measure change and predict outcomes of investments**	Citizen SW Review Panel	$50,000	2012

Water Quality Monitoring Milestones **Goal: Establish and maintain a regular, continuous monitoring program and achieve Class B standards by 2023.**
Milestone
• Birch Stream has 5 years of baseline data and is well-established by 2015
• Dissolved oxygen downstream of Maine Avenue is 7 ppm by 2020
• DEP will continue macroinvertebrate monitoring on 5 yr rotation schedule
• City will coordinate annual bio-survey to establish a cursory baseline for macroinvertebrate indicators by 2010
• A model for predicting the affects of new BMPs on the watershed will be chosen, implemented and maintained within 5 yrs

SEWALL
JAMES W. SEWALL COMPANY / Since 1880

Appendix B

Focus Area Descriptions and Details by Sub-watershed

Lower Sub-Watershed – Mall and adjoining properties

The BMPs recommended for this area were designed to treat water quality, quantity, channel protection and temperature control. This system collects runoff from a restaurant, a gas station, a Mall, and a car wash. The runoff entering the existing catch basin system behind the mall will be collected and treated in the proposed Stormtech system located behind the mall. Strategically placed Filterra systems area recommended for the front parking area and for the neighboring McDonald's restaurant to treat the runoff. These BMPs result in a 48% reduction in phosphorus and 77% treatment for channel protection. Details and drawings of the specific focus areas recommendations follow.

Focus Area 1:

This is the most intensive modification to the site. It will also provide the most benefit to not only the Airport Mall, but to several businesses and community facilities located north of Union Street within the Birch Stream Watershed. The proposed activities are located in what is currently a paved triangular parking area at the rear of the Mall. This area has 88 parking spaces which appear to be used only occasionally for parking. This area detail may be seen on Sheet FA-1 in Appendix B.

This retrofit proposes two distinct activities; the removal and revegetation of an existing 0.85-acre paved area, and the installation of an underground detention/filtration system to treat water quantity and quality.

The removal of pavement will by itself decrease the amount of storm water runoff from the area by allowing infiltration and evaporation of the rainfall. Once pavement is removed the area will be seeded and trees planted to create an area for Mall employees to have lunch or enjoy time outside. Runoff from this area will also be cooler due to the shading from trees and vegetation. Nearby residential properties may opt to use this area recreationally as well. This could be encouraged by installing a stairway to the adjacent Sunbury Village property. The view of the free flowing section of Birch Stream from this area will allow for potential wildlife or avian viewing opportunities.

The real workhorse of focus area one's water treatment system is located several feet beneath this park-like setting. By replacing about 160-ft of storm drain at the rear of the Airport Mall and adding three new catch basins, storm water that is now discharging directly into Birch Stream is rerouted into an underground treatment system. This system is comprised of approximately 389 Stormtech MC-3500 chambers. These chambers, the stone they are bedded in, and associated underdrained filters, will store, filter, and discharge runoff from up to, and including, the 25-year storm event of

4.8 inches in a 24-hour period. This includes all of the smaller, more frequent rain events. Equally important, they will capture storm water from the first flush of every storm.

The system is designed to discharge the retained storm water more gradually into the stream. This adds to base flow in the stream as well, creating a more stable aquatic environment.

Runoff from the roof of the Airport Mall drains to catch basins at the rear of the store. The existing roof is dark and transfers heat to this runoff. Some cooling will occur in the underground system. However, it is recommended that when this roof is repaired or replaced by Mall ownership that it should receive a white or light color surface. This will reduce heating of runoff as well as reduce air conditioning costs during the summer. If the roof is replaced, the new one should have a Solar Reflectance Index (SRI) of 78 or greater to meet LEED standards.

Focus Area 1 Cost Estimate

Activity	Qty.	Units	Completed Unit Cost	Total
Stormtech System	1	each	$85,000	$85,000
Catch basins	3	each	$3,000	$9,000
24" culvert	210	CF	$55.00	$11,550
			total	$ 105,550
		20% contingency		$ 21,110
		Focus Area 1 total		$ 126,660

Focus Area 2

Storm water runoff from the front entrance of the Mall that includes Hannaford, McDonald's and associated parking lots drains over the paved surface to the catch basin system that discharges directly to the existing concrete box culvert running under the center of the parking lot and the Mall.

Stormwater is easiest to treat close to the source. The best management practice being proposed in this focus area will filter all of the parking lot runoff through 16 Filterra® treatment systems (www.Filterra.com). This detail may be seen on Sheet FA-2 in Appendix B. These tree well treatment systems could be used to add or replace trees in parking lots and along roadways. The website reports their expected pollutant removals rates which are provided here. They do note that ranges varying with particle size, pollutant loading and site conditions.

- TSS Removal 85%
- Nitrogen Removal 43%
- Fecal Coliform 57% -76%
- Phosphorus Removal 73%
- Heavy Metal Removal 33% - 82%
- Predicated Oil & Grease >85%

Information on pollutant removal efficiency of the filter soil/plant media is based on more than three-years of lab and field studies performed by the Civil Engineering Department at the University of Virginia.

The Filterra® systems will be located to intercept storm water as it runs along curbs and toward the existing catch basins. These systems will be installed in the existing parking lot islands. Therefore, no parking spaces will be lost. Once the runoff enters the filterra it goes through a proprietary filter media where floatable trash and other materials are removed. After passing through the filter the runoff is collected in an underdrain system within the Filterra® box and routed to the existing storm collection system. When large storm events occur or the filters is at capacity the runoff is automatically bypassed to existing catch basins and discharged as it is now. The Filterra® systems will capture runoff from the first flush and frequent smaller storms.

Focus Area 2 Cost Estimate

Activity	Qty.	Units	Completed Unit Cost	Total
Filterra® Units				
Mall Lot (1-14)	1	LS	$ 202,140	$ 202,140
McDonald's Lot (15-16)	1	LS	$ 20,160	$ 20,160
Pavement Repair				
Mall Lot	5.83	TON	$150	$ 875
McDonald's Lot	0.78	TON	$150	$ 117
			Total	$ 223,292
			20% contingency	$ 44,660
			Focus Area 2 total	$ 267,952

Focus Area 3:

The treatment proposed for this area addresses the roughly triangular paved area to the right of Marshal's and behind McDonald's. This area is presently used partially as parking (62 spaces) and as a snow storage area during the winter. Due to the irregular shape much of the paved area is not appropriate for either parking or as a travel way. In addition to the revegetation an underdrained soil filter is being proposed between the new grassed area and the driving range. This area detail may be seen on Sheet FA-3 in Appendix B.

The proposed treatment is to remove approximately 0.88 acres of the pavement and restore vegetation to the area. Trees should be planted as well to cool the area.

Existing delivery access to the rear of the Mall will be maintained as will paved access from the rear of McDonalds and the adjacent property. This detail may be seen on Sheet FA-3 in Appendix B.

As in Focus Area 1, the removal of pavement will decrease the amount of runoff from the area by allowing infiltration of the rainfall. Runoff from this area will be cooler due to the effect of shade trees and evaporative cooling from the soil. The addition of the soil filter will also treat the area for pollutants as well as temperature control and provide some flooding control.

Alternatively, the Underdrain Soil Filter can be installed without the removal of pavement from this area. Costs for the recommended and the alternative system are included below:

Focus Area 3 Cost Estimate

Activity	Qty.	Units	Completed Unit Cost	Total
remove pavement	4275	SY	$7.00	$ 29,925
4" loam & seed	4275	SY	$4.00	$ 17,100
trees	20	each	$100.00	$ 2,000
curbing	720	LF	$3.50	$ 2,520
Underdrain Soil Filter	1	LS	$25,000	$ 25,000
			total	$ 76,545
		10% Contingency		$ 7,655
		Focus Area 3 total		$ 84,200
Alternative				
Underdrain Soil Filter Only	1	LS	$71,000	$ 71,000

total	$ 71,000
20% Contingency	$ 14,200
Focus Area 3 total	$ 85,200

Focus Area 4

This Focus Area is the main parking area in front of Marshal's and Staples. This detail may be seen on Sheet FA-4 in Appendix B. The proposed retrofit would increase vegetation and create shade by placing new trees in islands that divide the parking lot, therefore helping to cool the runoff. The additional benefit of this recommendation is that it would better define a conventional, safer traffic flow pattern that will help this area conform to the City of Bangor parking standards. The islands will force drivers to follow conventional travel paths and eliminate, for the most part, the diagonal crossing of several rows of parking lanes. At the southeast end of the parking area a narrow island is proposed to prevent drivers from backing or driving out of a parking space directly into a travel lane. Restriping of the truck route on the south end will better define turning and travel lanes further enhancing driver understanding of the area. This recommendation is optional and could be achieved elsewhere on the mall property to reduce runoff volume and pollutants.

Focus Area 4 Cost Estimate

Activity	Qty.	Units	Completed Unit Cost	Total
remove pavement	1200	SY	$7.00	$8,400
4" loam & seed	1200	SY	$4.00	$4,800
trees	27	each	$100	$2,700
curbing	3709	LF	$3.50	$12,982
striping	4800	LF	$1.30	$ 6,240
			Total	$ 35,122
		10% contingency		$ 3,512
		Focus Area 4 total		$ 38,634

Focus Area 5:

Similar to Focus Area 4, the treatment proposed in the parking area between the Airport Mall and Griffin Road also increases traffic safety. Grassed islands would be added to the parking lot and the lot would be restriped to prevent drivers from backing or driving into the travel lane at the southwest side of the lot. The islands and plantings will conform to current City of Bangor standards.

Approximately 0.092-acres of pavement would be removed and reseeded at the north edge of the parking area. This revegetation will reduce runoff and help to lower the temperature of stormwater. The shape of the proposed revegetation area will also act as a traffic calming measure to discourage drivers from exiting and entering the rear of the Mall at high speeds. Trees planted in this area will shield nearby residences from headlights at the rear of the Mall as well. This recommendation is optional and could be achieved elsewhere on the mall property to reduce runoff volume and pollutants.

Focus Area 5 Cost Estimate

Activity	Qty.	Units	Completed Unit Cost	Total
remove pavement	967	SY	$7.00	$6,769
4" loam & seed	967	SY	$4.00	$3,868
trees	37	each	$100	$3,700
curbing	3275	LF	$3.50	$11,463
striping	7713	LF	$1.30	$10,027

Total	$35,827
10% contingency	$ 3,583
Focus Area 5 total	$ 39,410

Several of the proposed focus area improvements would remove parking spaces. It should be noted at the outset that there are currently about 412 parking spaces more than required by the City of Bangor. If all Focus Areas are acted upon as designed, there would be a total of 1120 parking spaces remaining at the Mall which still exceeds the City minimum of 858 by 30%. The proposed changes to the parking areas would also bring them more in line with current City regulations for green spaces and enhance safety of the parking lot by breaking up the sometimes confusing traffic patterns that currently exist.

Upper Sub-Watershed Retrofit Descriptions – Bangor International Airport

International Canal Stormwater System

The Best Management Practices for the International Canal portion of the airport stormwater system are targeted at reducing the Biochemical Oxygen Demand (BOD) caused by Propylene Glycol in stormwater runoff. This is considered the key water quality stressor at this location, and impacts dissolved oxygen levels in downstream areas of the stormwater system. The combination of powered and supplementary aeration, detention, filtration and wetland treatment is designed to provide a reduction of approximately 80% in the BOD load under base flow conditions (+/- 1cfs). The Upper Quartile BOD concentration from recorded values at the head of the International Canal system between 2005 and 2009 was 185mg/L. The treatment system is designed to reduce this to approximately 37mg/L prior to dilution by other system inflows. The overall dilution factor provided by other system flows upstream of the Detention Basin Dam is in excess of 8:1. Therefore, the expected BOD at the Detention Basin outlet during baseflow conditions is approximately 5mg/L.

During storm conditions the system retention time, and hence treatment efficiency of the BMPs will be significantly reduced. However, this will be coupled with a significant increase in both the volume and rate of runoff from contributing areas. The increased flow will dilute the pollutant concentration in the influent and substantially offset the reduced level of treatment. Outflow BOD concentrations are expected to remain around the same level during storm events as during baseflow conditions.

The pre-treatment provisions in the International Canal system include stabilized channels, outlet aprons and check dams. These are designed to trap coarse suspended solids in runoff entering the system. An Under-drained Filter is also included in the upstream portion of the system to aid in the removal of finer suspended solids from the flow. Under baseflow conditions it is estimated that these BMPs will reduce Total Suspended Solids (TSS) in the runoff by 70-80%. During storm conditions, higher flow rates will decrease settling potential and reduce the efficiency of the treatment BMPs. It is estimated that during a one-inch, 24-hour storm event (90% storm) TSS removal rates will drop to around 40%. During larger storm events TSS removal performance will

be difficult to predict, as surcharging of the system will introduce significant amounts of debris and other washdown materials from areas not normally exposed to moving water.

Domestic Canal Stormwater System

The improvements to the Domestic Canal system are targeted at reducing Total Suspended Solids (TSS) and reducing Thermal Impacts to downstream receiving waters. These are both identified as key stressors in the Birch Stream watershed. The stabilized low-flow channel and check dams will significantly reduce during baseflow conditions. Even with the large contributing area, TSS removal rates of 70-80% should be expected under these conditions. As with the International Canal system, it is estimated that during a one-inch, 24-hour storm event (90% storm) TSS removal rates will drop to around 40%. During larger storm events TSS removal rates will vary seasonally, and depending on vegetation condition, rate of system inflow and maximum water elevation.

The new configuration will reduce the potential for thermal impacts to downstream receiving water by significantly reducing the area of shallow, slow flowing, or standing water in the Domestic Canal system. The improved channel will increase the low flow velocity through the system, and provides areas for riffles that will promote aeration. New low flow outlets at the Detention Basin dam provide gravel filters to cool the outflow before it discharges towards Union Street. Historical data from Birch Stream (MDEP BLWQ Birch Stream report 2003) indicates maximum weekly water temperatures above 25C during the summer months. It is probable that water temperatures in the BIA Domestic Canal system were at this level prior to construction of the current improvements. Temperature reductions are difficult to predict due to variable influences from groundwater and other subsurface inflows. However, it is estimated that maximum weekly temperatures in the improved Domestic Canal system will be 3C-5C lower than before the work.

Godfrey Boulevard Bio-retention Swale

The new Bio-retention Swale in the center of Godfrey Boulevard provides water quality treatment for the contributing paved areas in accordance with the State of Maine Stormwater BMP Manual. The swale is expected to provide 80% TSS removal and 65% Phosphorus removal for runoff from the contributing area of approximately two acres of pavement.

Peak Stormwater Outflow from the BIA System

The BIA Stormwater Improvements will moderate outflows from the airport stormwater system, particularly during baseflow conditions and small, frequent storm events. The new Detention basin outlets and the reduction in the standing water elevation in the Domestic Canal system combine to reduce peak outflow from the system by approximately 48% in a one-inch, 24-hour storm event (90% storm). The reductions in peak outflow rates provided by the new system become smaller as the storms become larger and less frequent. A reduction of approximately 20% is predicted for the 2-year (or 50%), 24-hour storm, and reductions of just over 10% are predicted for the 10-year (10%) and 25-year (4%) storms.

Upper Sub-Watershed Retrofit Descriptions – Maine Army National Guard

The Army Guard site has two existing soil filter systems on site for work that was completed in the past few years. These systems are sized and are functioning properly for the area they are treating. A Stormtech system is being recommended to treat the remainder of the site which is largely impervious. The combination of the existing and proposed systems will treat water quality, quantity,

temperature, and provide channel protection. These BMPs are expected to result in a 45% reduction in phosphorus and 87% treatment for channel protection.

East Sub-Watershed Retrofit Descriptions – Health Care Plaza

The recommendations for this area includes a combination of soil filter systems, Filterras, and buffers to improve the quality of the stream. These systems will treat water quality, quantity, temperature, and provide some channel protection. This area collects runoff from the Penobscot Community Health complex including a fast food restaurant. These BMPs result in a 25% reduction in phosphorus and 25% treatment for channel protection. See the draft drawings showing the recommended placement of the systems and their approximate size located below.

Center Sub-Watershed Retrofit Descriptions – Various Properties

The BMPs recommended for this area are designed to treat water quality, quantity, temperature, and provide some channel protection. This area collects runoff from a Department of Human Services, an autopark, a fitness center, and three other facilities. This plan recommends a combination of soil filter systems, Filterras, and buffers to treat runoff. These BMPs result in a 48% reduction in phosphorus and 74% treatment for channel protection. Draft plans showing the recommended placement of the systems and their approximate size are located below.

All Other Area Retrofits

Buffers are a cost effective recommendation on properties that abut the stream or tributaries. In areas where buffers are proposed the runoff must enter the buffer as sheet flow unless a level spreader is installed. This may require resurfacing or regrading of the parking lot to ensure that the runoff does not become concentrated in cracks, or seams, or get directed to low spots in the parking lot.

Recommend a 150' easement for a buffer near edge of the stream opposite Department of Human Services where there is currently an abandoned paved area.

Recommend that fast food restaurant and gas stations install oil/water separators whenever major improvements of tanks or parking areas are made.

Residential and retail property owners should install rain gardens and/or disconnect roof drains from storm system drainage wherever possible.

Recommend Penobscot Job Corps Academy develop a comprehensive list of Low Impact Development retrofits to be installed over time.

Union Street is a big contributor, therefore, the City will work with MDOT to get BMPs installed to treat the petroleum and salt pollutants coming from the road, shoulders, ditches and right-of-ways.

Recommend dumpster pads under existing dumpsters in all areas of the Birch Stream Watershed.

Recommend use of temporary filters to remove PAH's during pavement resurfacing.

Appendix C

Water Quality Calculations for Priority Sites

Appendix D

Complete Benthic Modeling Data