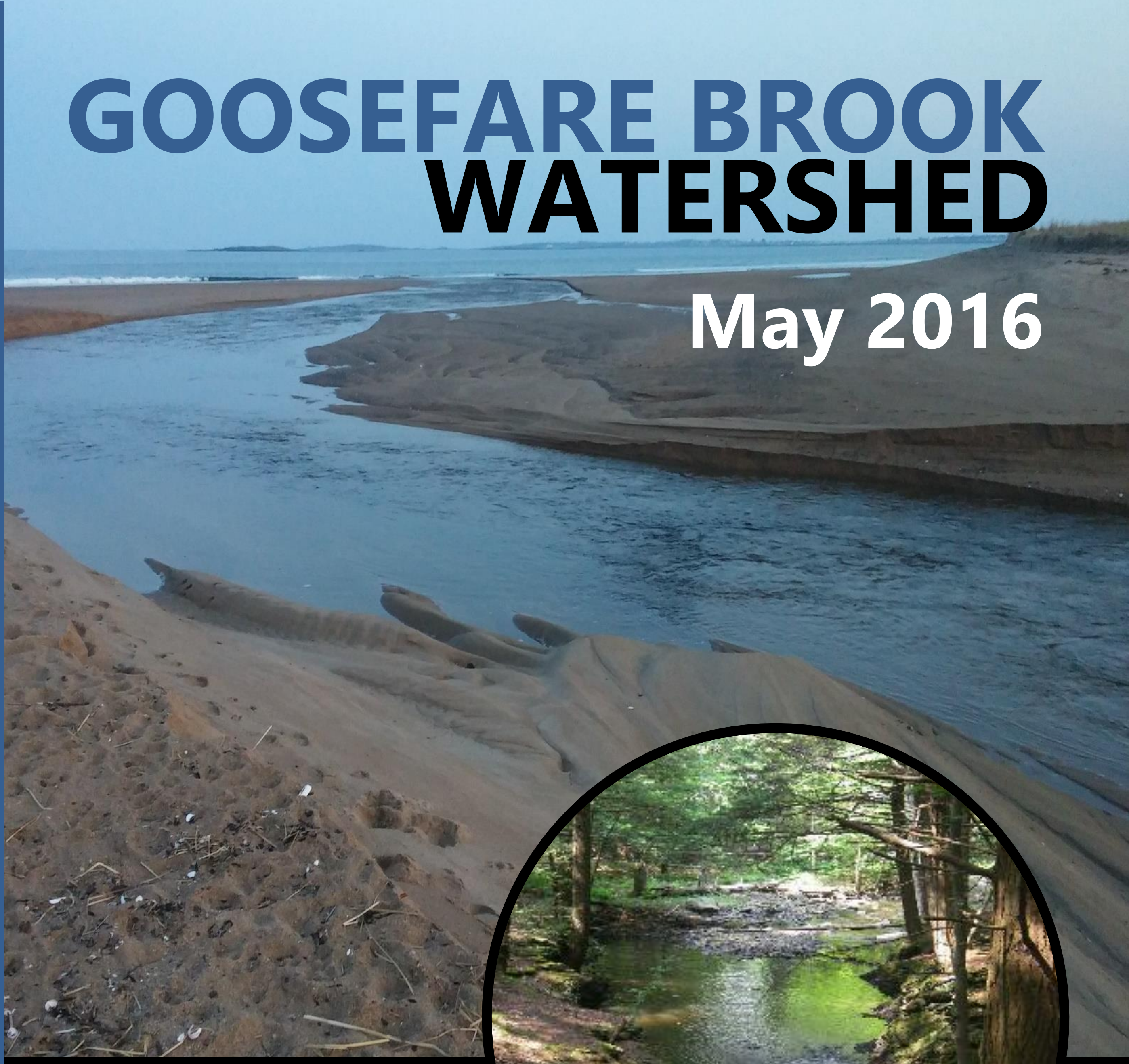
WATERSHED-BASED MANAGEMENT PLAN

GOOSEFARE BROOK WATERSHED

May 2016



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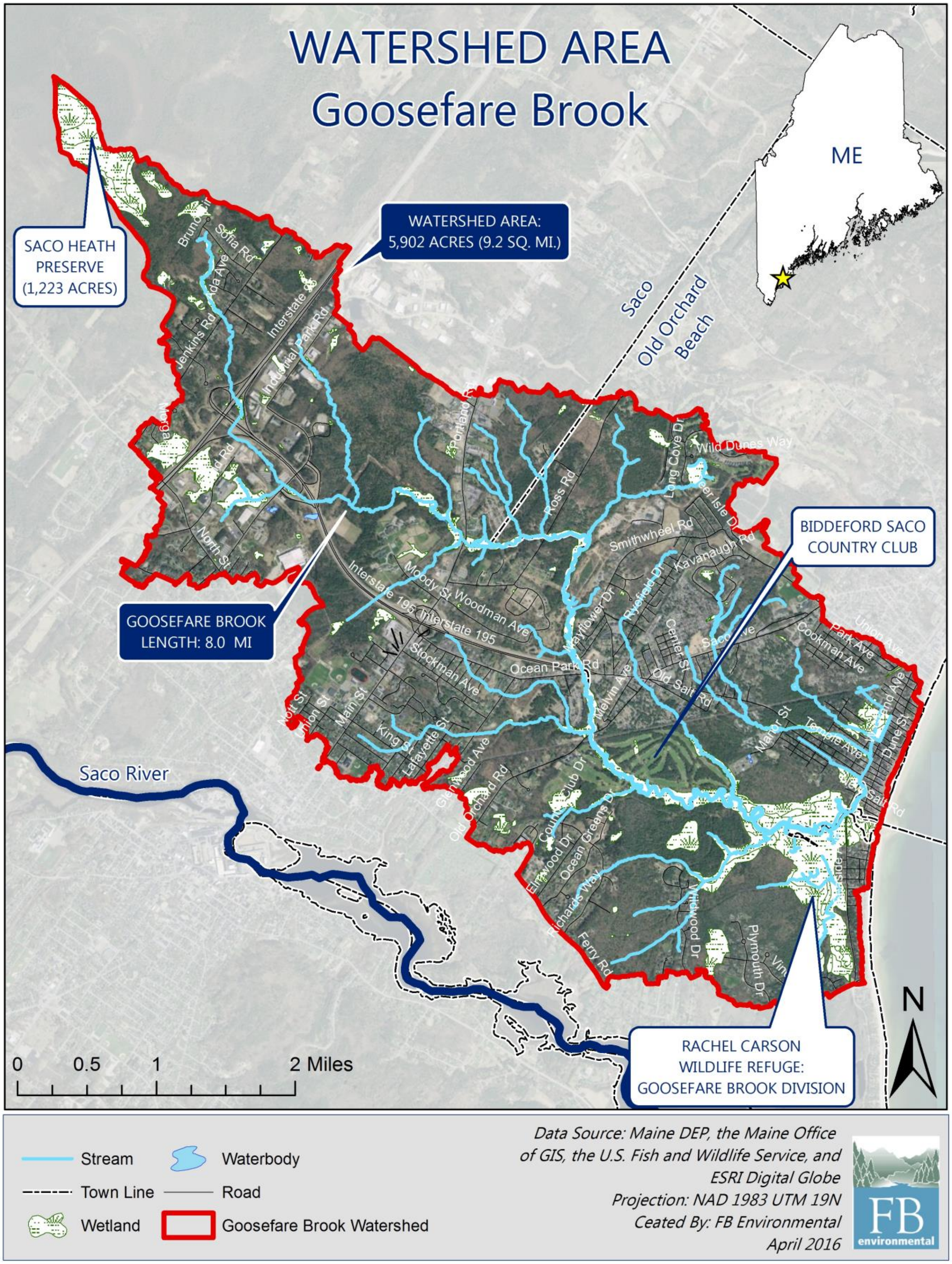
WATERSHED AREA
Goosefare Brook
ME
WATERSHED AREA: 5,902 ACRES (9.2 SQ. MI.)
SACO HEATH PRESERVE (1,223 ACRES)
Saco
Old Orchard Beach
BIDDEFORD SACO COUNTRY CLUB
GOOSEFARE BROOK LENGTH: 8.0 MI
Saco River
RACHEL CARSON WILDLIFE REFUGE: GOOSEFARE BROOK DIVISION
0 0.5 1 2 Miles
N
Stream
Waterbody
Town Line
Road
Wetland
Goosefare Brook Watershed
Data Source: Maine DEP, the Maine Office of GIS, the U.S. Fish and Wildlife Service, and ESRI Digital Globe
Projection: NAD 1983 UTM 19N
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April 2016
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EXECUTIVE SUMMARY

PROJECT OVERVIEW

The Goosefare Brook Watershed-Based Management Plan (WBMP) is a comprehensive plan that serves to provide the City of Saco and the Town of Old Orchard Beach with recommendations for protecting and restoring Goosefare Brook and its tributaries. The goals of the plan include:

- Improve Goosefare Brook water quality and habitat so it meets state standards and is safe for human contact.
- Protect the stream and its tributaries from current and future impacts.
- Raise public awareness and create and maintain community support for restoring Goosefare Brook.

This can be achieved using a combination of on-the-ground stormwater retrofits, stream corridor improvements, sewer and septic system improvements, community education and outreach, and other activities that focus on reducing pollutant sources and other stressors that contribute to the stream's impairment.

Development of this plan included compiling and analyzing historical water quality data with significant input from the Maine Department of Environmental Protection (Maine DEP); updating the existing GIS land cover and watershed data; conducting field assessments in the stream and developed watershed areas; evaluating pollutant load reductions; and gathering feedback from local stakeholders. This information was used to identify water quality problems, define management objectives, and prioritize protection and restoration strategies for the watershed.

The Goosefare Brook 'Gorge" behind the Sweetser School. PHOTO CREDIT: Maine DEP.

THE GOOSEFARE BROOK WATERSHED

Goosefare Brook is an urban impaired stream located in both the City of Saco and the Town of Old Orchard Beach. This 8.0-mile-long stream flows through both natural and highly developed areas before discharging to the Atlantic Ocean near one of the most popular beach destinations along the coast of Maine. Commercial, industrial and high-density residential development occupies a significant portion of the watershed (land draining to the stream) and contributes stormwater runoff to Goosefare Brook and its tributaries. Refer to map on inside cover and Appendix I, Map A. These areas, such as the Route 1 corridor in Saco and high density residential development in Old Orchard Beach, have large volumes of stormwater runoff and little stormwater filtration before runoff enters groundwater and surface water within the watershed. Additionally, legacy toxics from closed industrial facilities may still be present in groundwater and the stream, compounding the challenging conditions for aquatic life.

Despite these issues, Goosefare Brook has sustained areas of natural beauty that provide motivation and inspiration for stream restoration efforts. This includes the Saco Heath at the headwaters of the stream, several near-pristine tributaries, and the Rachel Carson Wildlife Refuge, which conserves a large segment of the tidal reach of Goosefare Brook. These unique areas offer rich habitats for sustaining a large diversity of terrestrial and aquatic flora and fauna.

THE PROBLEM

Goosefare Brook does not meet its statutory Class B classification for aquatic life use, based on non-attainment for macroinvertebrates, and toxic metals (cadmium, chromium, copper, iron, nickel, lead, and zinc; Maine DEP 2003). The stream and its main tributary, Bear Brook, are also on the 303(d) list of impaired waters for bacteria (Maine DEP 2014). Portions of the stream that are not meeting Class B standards are downstream of major development, highlighting the need to minimize stormwater runoff and reduce other impacts from developed areas (Maine DEP 2012).

An analysis of the Goosefare Brook watershed reveals that 14% (832 acres) of the watershed is made up of total **impervious cover (IC)**, such as parking lots, roofs, and sidewalks. However, this IC is primarily concentrated in five of the sixteen subwatersheds (Bear Brook North Branch (31.3%), Industrial Park South (26.5%), Route 1 North (23.6%), Bear Brook South Branch (23.6%), and New Salt Road Tributary West Branch (19.9%). In contrast, several subwatersheds have low total IC (ex. IMAX Stream (4.9%), and Branch Brook 5.4%). Research shows that watersheds with IC greater than 10% often exceed criteria for aquatic life use (Stanfield and Kilgour 2006), and even lower levels of IC (4-6%) can significantly impact the abundance and diversity of fish and macroinvertebrate species (Wenger et al. 2008). Due to a combination of high IC and threats to water quality (see discussion below), four of these five subwatersheds have been designated as high priority for restoration (all but Route 1 North).

> **IMPERVIOUS COVER (IC),** such as parking lots, roofs, and sidewalks, from high density commercial businesses, generates runoff to the stream. Stormwater carrying dirt, metals, and other pollutants is conveyed directly from IC to the stream with minimal pre-treatment, causing increased erosion, sedimentation, increased temperature, and habitat degradation in the stream (CWP 2003).

Estimated Reductions from Proposed Stormwater Retrofits in the Goosefare Brook Watershed 2015 - 2030:	
42,482 lbs/yr	Total Suspended Sediments (TSS)
28 lbs/yr	Total Phosphorus (TP)
293 lbs/yr	Total Nitrogen (TN)

In the Goosefare Brook watershed, these highly developed subwatersheds have commercial development that appears to be linked to the aquatic life use and bacteria impairments in Goosefare Brook and its tributaries. Stormwater runoff from these impervious surfaces carries contaminants such as excess nutrients, heavy metals, and bacteria into the stream. Restoration of Goosefare Brook and its tributaries is targeted in these subwatersheds with high IC and commercial development as they are most likely the largest contributors to the degraded water quality in the streams. Structural BMPs in this plan are estimated to reduce 42,482 lbs./yr. of total suspended sediments (TSS) in stormwater runoff, as well as 28 lbs./yr. total phosphorus (TP) and 293 lbs./yr. total nitrogen (TN).

> A good restoration plan acts as a road map pointing out where to start, what visits to make in the watershed, how long it will take to get there, how much it will cost, and how you know you've arrived.

The recommendations made in this plan are separated into Phase I and Phase II implementation over a fifteen-year time period (2016-2031). Phase I outlines actions that address sources linked to priority stressors in impaired subwatersheds and actions that provide multiple stream protection benefits. Phase I action items are planned for completion in the first ten years of plan implementation (by 2026). Phase II actions may be needed if Phase I does not result in stream attainment, and the actions are also important to protect the stream from further degradation. Phase II targets lower priority pollution sources that may be linked to stream impairment or provide stream protection benefits from secondary stressors. This plan targets completion of Phase II BMPs by 2031 as needed to reach attainment. While this plan should be viewed as a guideline for achieving attainment, every stream and its aquatic communities will respond differently to restoration activities, and Goosefare Brook may or may not reach attainment before or after Phase I implementation is completed. If Phase I management measures recommended in this plan do not improve water quality to the point of reaching attainment, it is recommended that Saco and Old Orchard Beach re-assess options provided in Phase II of this plan. This plan should be reassessed after five years and updated after ten years to evaluate the goals and achievements of the plan. It is important to note that costs and implementation timelines recommended in this plan are estimates and will need to be adjusted contingent on funding availability, stakeholder involvement, and site-specific design.

Furthermore, in addition to the structural managements mentioned above, non-structural management measures, such as planning to prevent adverse effects from future development, and maintaining existing BMPs will be a priority. Watershed-wide, non-structural management practices (including street sweeping, salt reduction, catch basin cleaning, etc.) are expected to reduce pollutants in the watershed by approximately an additional 10% (Law et al. 2008, FBE 2011).

WHY DEVELOP A WATERSHED-BASED MANAGEMENT PLAN?

A watershed-based management plan (WBMP) helps identify problems, priorities, and actions that are needed to protect and improve the water quality of a waterbody. The Goosefare Brook WBMP has been developed with a strong stakeholder process in order to ensure that the major issues and concerns of both the community and the stream are addressed. An Action Plan (Section 5.1.1) was developed based on feedback from the Steering Committee, Technical Advisory Committee (TAC), and the public. These stakeholders met on multiple occasions and discussed what they perceived to be the greatest threats to the stream's water quality, and developed practical solutions to address them.

Successful implementation of this plan, including final selection of key restoration strategies, requires an integrative and adaptive approach and depends primarily on the involvement of the City of Saco, the Town of Old Orchard Beach, various partners and stakeholders, and the watershed community. These partnerships help strengthen the plan by increasing both public awareness of the problems and public commitment to the solutions. A community-based plan also helps attract private, state, and federal funding and provides opportunities for both recreational and aesthetic improvements. This plan will help foster further thinking about long-term strategies for improving water quality and related natural resources within the Goosefare Brook watershed, and help to promote communication among citizens, municipalities, and state agencies. This plan is contingent on landowner cooperation, since a large portion of the watershed targeted for restoration over the next fifteen years is privately owned. In addition to the reasons listed above, proactive efforts by Goosefare Brook stakeholders will also help prevent citizen lawsuits and U.S. Environmental

KEY PROTECTION AND RESTORATION CATEGORIES

Goosefare Brook

- **Stormwater Best Management Practices (BMPs) -** *Reduce the rate of stormwater discharge and the pollutants it carries to Goosefare Brook by installing innovative conservation practices that capture, filter, cool, and slow runoff from paved areas, rooftops, and other impervious surfaces.*
- **Bacteria Source Reduction-** *Continue to seek out and remove bacteria sources in the watershed.*
- **Stream Restoration-** *Improve habitat conditions in and adjacent to the stream by restoring riparian buffers, stabilizing eroding stream banks and removing fish barriers.*
- **Education & Outreach-** *Garner the support and cooperation from community groups while educating business owners, school children, and watershed residents about the need for and importance of clean water.*
- **Good Housekeeping Practices-** *Work with municipal employees and watershed businesses to improve existing stormwater infrastructure, catch basin cleaning, winter sand/salt spreading, snow storage, and street sweeping.*
- **Land Conservation & Land Use Planning-** *Coordinate local efforts to increase the amount of land in permanent conservation and work with municipal officials* to *expand riparian buffer zoning and improve local stormwater rules in order to protect streams.*
- **Water Quality Monitoring-** *Conduct ongoing water quality and macroinvertebrate monitoring to assess stream conditions and changes over time.*

Protection Agency (USEPA) petitions that have been filed in other communities to force restoration of impaired waters. Developing a WBMP that meets USEPA guidelines also enables project partners to seek future USEPA and Maine DEP funding to help implement plans.

WHAT THE PLAN INCLUDES

The plan is divided into seven major sections and includes the US EPA's nine key planning elements for watershed management plans *(referred to as elements a through i)*:

- **SECTION 1** describes the purpose of the plan, provides background information about Goosefare Brook, a description of the planning process, and a brief description of recent efforts in the watershed (*element a*)
- **SECTION 2** describes the watershed, including local climate, demographics and growth trends of Saco and Old Orchard Beach, land cover, topography, land conservation, soils and geology, and stormwater/sewer infrastructure. This section also describes the sixteen subwatersheds within the Goosefare Brook watershed.
- **SECTION 3** describes causes of impairment and applicable water quality standards, summarizes water quality and biological assessment data collected from Goosefare Brook, and summarizes the results of a Stream Corridor Assessment (conducted in 2015 by the Maine DEP) geomorphic reconnaissance, and a fish barrier study by the Nature Conservancy and US Department of Fish and Wildlife Service (USFWS) (*element a*).
- **SECTION 4** identifies impaired subwatersheds and describes their stressors (*element a*).
- **SECTION 5** describes watershed restoration goals and objectives. Both structural and non-structural restoration opportunities and recommendations are discussed. Action strategies are presented in tables describing what needs to be done, how it will be done, who will help get it done, when it will be done, and how much it will cost. Restoration strategies are divided into several primary categories (shown above). Section 5.3 provides the results of a pollutant loading reduction analysis for the recommended structural management measures (*elements, b, c, e, f*)
- **SECTION 6** describes plan implementation, including who is in charge of administering the plan, and summarizes actions, costs, and technical assistance needed to ensure progress (*element d*).
- **SECTION 7** describes specific recommendations for monitoring and evaluating the effectiveness of restoration efforts. This includes criteria for measuring progress and measurable milestones along the way (*elements g, h, i*).

FUNDING THE PLAN

The total estimated cost for implementing the Goosefare Brook WBMP is approximately **$1,866,000 – $2,301,700, or approximately $140,000 per year over the next 15 years**, including all structural and non-structural recommendations described in this plan. This cost is an estimate to guide plan implementation and should not be considered as finalized for site-specific implementation.

ADMINISTERING THE PLAN

The Goosefare Brook Restoration Committee will be formed to administer the Goosefare Brook WBMP. The City of Saco and Town of Old Orchard Beach will take a lead role in convening the group and serve on the committee. Other stakeholders including elected officials, watershed business owners, and other interested groups will also be involved. The Committee will meet at least two to four times each year to provide periodic updates to the plan, track and record progress made toward restoration, maintain and sustain action items, and make the plan relevant on an ongoing basis by adding new tasks as needed. The Committee should track achievements, press coverage, outreach activities, number of retrofits sites repaired, number of volunteers, and amount of funding received.

15-YEAR COST ESTIMATE FOR RESTORING GOOSEFARE BROOK		
Category	**Estimated Annual Costs**	**15-year Total**
Structural BMPs		
Stormwater Retrofit Sites[1]	$90,367 - $118,100	$1,355,500 - $1,771,500
Stream Corridor Restoration	$16,667	$250,000
Retrofit Maintenance	$4,333 - $5,647	$65,000 - $84,700
Non-Structural BMPs		
Administrative & Funding	$1,067	$16,000
Education & Outreach	$767	$11,500
Municipal Maintenance	$167	$2,500
Land Use Planning and Conservation	$2,000	$30,000
Source Control	$1,200	$18,000
Monitoring Program		
Monitoring	$7,833	$117,500
GRAND TOTAL (15-yr)	**$124,401 - $153,448**	**$1,866,000 - $2,301,700**

NEXT STEPS

The success of this plan can be measured in several ways, as outlined in Section 7.3, Measurable Milestones. These milestones fall under three categories: environmental, programmatic, and social indicators. These indicators can be used as performance measures to determine how well implementation activities are working and provides a means to track progress toward established goals and objectives. These measurable milestones are given 'benchmarks' or goals for restoration progress. Key milestones identified in this plan are provided in the table on the following page.

[1] Retrofit costs listed include both Phase I and II sites. Significant cost savings will be realized if restoration goals are met after Phase I sites are addressed. Phase I retrofit cost estimates range from $558,500 - $749,500.

Measurable Milestones			
Indicators	**Benchmarks***		
	2021	**2026**	**2031**
Environmental			
Reduction in Total Phosphorus (TP) from stormwater *GOAL: 420 lbs. reduction in modeled TP*	10% of goal	50% of goal	100% of goal
Improvement of the stream channel and corridor through reduced erosion, increased buffers, and necessary channel alterations *GOAL: 72 Sites*	20 sites addressed	40 sites addressed (Phase I)	72 sites addressed
Eliminate bacteria sources on Goosefare Brook, New Salt Road Tributary, Bear Brook and other targeted hotspots *GOAL: Geometric means for all sites meet applicable freshwater or estuarine state requirements*	10% of goal	50% of goal	100% of goal
Programmatic			
Amount of funding secured for plan implementation through fundraisers, donations, and grants.	$700,000	$1,400,000	$2,100,000
Number of areas installed with structural BMPs	10	25	52
Number of non-structural restoration activities completed	5	10	15
Social			
Number of volunteers participating in educational campaigns	50	100	150
Number of people participating in workshops or demonstrations	20	50	75

**Benchmark figures are cumulative from 2021 to 2026 to 2031*

Successful implementation of the Goosefare Brook WBMP depends primarily on the commitment and involvement of community members. Therefore, the success of this plan will weigh heavily on the support and cooperation of the City of Saco, the Town of Old Orchard Beach, and other key stakeholders. All of the stakeholders will need to enthusiastically engage the community in restoration activities, work together to maintain the sustainable funding plan, and acquire additional funds to implement the suggested work. The City of Saco, in partnership with the Town of Old Orchard Beach, should officially adopt the plan, thereby raising awareness about the importance of restoration efforts and the need for immediate action.

ACKNOWLEDGEMENTS

This plan is dedicated to the memory of John Bird.

John's passion and perseverance helped bring Goosefare Brook into the public eye and was felt through every stage of this project. His caring nature, local insights, and thoughtful advocacy will be sorely missed as we move forward with restoration efforts.

GOOSEFARE BROOK STEERING COMMITTEE:

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John Bird, *The Ocean Park Conservation Society*
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Ken Blow, *Town of Old Orchard Beach Town Council*
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ACRONYMS *(In alphabetical order)*

ACRONYM	DEFINITON
As	Arsenic
BMP	Best Management Practice
CCC	Criteria Chronic Concentration
CFUP	Compensation Fee Utilization Plan
CMC	Criteria Mean Concentration
COC	Contaminants of Concern
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
FIB	Fecal Indicator Bacteria
FTALs	Fish Tissue Action Levels
IC	Impervious Cover
LID	Low Impact Development
Maine IF&W	Maine Department of Inland Fisheries and Wildlife
MDC	Maine Department of Conservation
ME DEP	Maine Department of Environmental Protection
MEGIS	Maine Office of Geographical Information Systems
Metals	Cadmium (Cd), Chromium(Cr), Copper(Cu), Iron(Fe), Nickel(Ni), Lead (Pb), Zinc(Zn)
MGS	Maine Geological Survey
MHB	Maine Healthy Beaches
NWI	National Wetland Inventory
NOEC	No Observable Effects Concentrations
NCDC	National Climatic Data Center
NRCS	Natural Resources Conservation Service
Nutrients	Total Phosphorus (TP), Ortho-Phosphate (PO_4^{3-}), Total Dissolved Nitrogen (TDN), Dissolved Organic Nitrogen (DON), Dissolved Inorganic Nitrogen (DIN), Ammonium (NH_4^+), Nitrite (NO_2^-), Nitrate (NO_3^-)
OPA	Ocean Park Association
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
RGA	Rapid Geomorphic Assessment
SCA	Stream Corridor Assessment
SpC	Specific Conductivity
SVLT	Saco Valley Land Trust
SVOC	Semivolatile Organic Compounds
SWAT	Surface Water Ambient Toxics
SWQC	Surface Water Quality Control
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compounds
WBMP	Watershed-Based Management Plan
YCSWCD	York County Soil and Water Conservation District

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1 INTRODUCTION

1.1 PURPOSE AND BACKGROUND

Small (1st and 2nd order or headwater) streams and their associated network of wetlands help sustain the biological productivity of downstream rivers, lakes, and estuaries. These small streams recycle nutrients, create habitat, and maintain biological diversity for plants and animals, including fish species such as salmon and trout (Meyer et al. 2007). Small streams also provide natural flood control, recharge the groundwater, and maintain water quality by trapping sediments and pollution from fertilizers and other contaminants (Allan and Castillo 2007). Streams also offer intrinsic benefits to our communities by providing a sense of place for the people who live near them and a place for children to grow and explore the natural world around them.

Human activities that lead to increases in urban runoff, such as land clearing and development threaten the numerous benefits afforded by small stream networks. Poorly planned development most often results in riparian (streamside) vegetation and watershed hydrology alterations, water quality degradation and invasive species introduction. These consequences not only impact the health of aquatic life, but also our physical, social, and economic health. Conservation efforts, including protection of the riparian zone, preservation of undeveloped forest buffers, and implementation of low-impact development techniques that prevent stormwater runoff from developed areas will help protect these small streams for future generations.

Goosefare Brook does not meet its statutory Class B classification for aquatic life use, based on non-attainment for macroinvertebrates, and toxic metals (cadmium, chromium, copper, iron, nickel, lead, and zinc; Maine DEP 2003). The stream and its tributary, Bear Brook, are also on the 303(d) list of impaired waters for bacteria (*Escherichia coli*; Maine DEP 2014). Portions of the stream that are not meeting Class B standards are downstream of major development, highlighting the need to minimize stormwater runoff and reduce other impacts from developed areas or to increase the

A naturalized stretch of Goosefare Brook. PHOTO CREDIT: FBE.

level of stormwater filtration prior to discharge (Maine DEP 2012).

Despite these issues, Goosefare Brook has sustained areas of natural beauty that provide motivation and inspiration for stream restoration efforts. This includes the Saco Heath at the headwaters of the stream, several near-pristine tributaries, and the Rachel Carson Wildlife Refuge, which conserves a large segment of the tidal reach of Goosefare Brook. These unique areas offer rich habitats for sustaining a large diversity of terrestrial and aquatic flora and fauna.

A Goosefare Brook watershed sign.
PHOTO CREDIT: Maine DEP.

1.2 DEVELOPING A COMMUNITY-BASED WATERSHED MANAGEMENT PLAN

A watershed-based management plan (WBMP) helps identify problems, list priorities, and outline actions that are needed to improve the water quality of a stream (EPA 2008). A good plan acts as a road map pointing out where to start, how long it will take to get there, how much it will cost, and how you know you've arrived. Since each watershed is unique, the watershed-based management plan is also unique in order to address the major issues and concerns of the community.

Successful development of this watershed restoration plan depended primarily on the commitment and involvement of community members. These partnerships helped strengthen the plan by increasing both public awareness of the problems and public commitment to the solutions. Many of the recommendations of this plan will require landowner cooperation with the municipalities to implement retrofits on private land. As such, it will be important to develop a strong education and outreach program that targets residents of the Goosefare Brook watershed in an effective and trusting way; once landowners understand the importance of restoring Goosefare Brook, they may be more likely to participate in the restoration process.

The following groups or individuals have been identified as potential public participants to implement recommended actions to restore Goosefare Brook:

- City of Saco
- Town of Old Orchard Beach
- Rachel Carson Wildlife Refuge
- Saco Valley Land Trust (SVLT)
- Ocean Park Conservation Society
- Ocean Park Association
- Old Orchard Beach Conservation Commission
- Thornton Academy
- Old Orchard Beach High School
- Saco Conservation Commission
- Maine Healthy Beaches
- Maine Department of Environmental Protection (Maine DEP)
- York County Soil and Water Conservation District

> *"Running from the Heath to Saco Bay, Goosefare Brook is a hidden gem that should not be overlooked in its importance to the surrounding community and wildlife habitat" – Joe Laverriere, City of Saco, City Engineer*

- Maine Department of Transportation (Maine DOT)
- Maine Turnpike Authority
- Eastern Trail Alliance and Saco Bay Trails
- City of Saco School Departments (K – Middle School)
- Town of Old Orchard Beach School Departments (K – Middle School)
- General Dynamics
- Sweetser School
- Biddeford and Saco Country Club

Local partners have demonstrated a strong commitment to improving water quality conditions at Goosefare Brook. In terms of partner involvement in this planning process, the Goosefare Brook Steering Committee met four times from June 2014 – April 2016 to discuss concerns about Goosefare Brook; plan the community meeting; brainstorm the action items for the watershed plan; and provide input on plan adoption and outreach efforts. Two subcommittees participated in additional meetings to provide detailed input and analysis for the planning process. Over 60 people attended the Goosefare Brook Community Meeting in June 2015 to learn about the project and provide input for the plan.

A Stream Monitoring and Assessment Committee (SMAC) meet three times in 2014 and 2015 to develop each summer's monitoring plan, review collected data and identify stream stressors. Two Technical Advisory Committee (TAC) meetings held on January 5th and 15th of 2016 enabled stakeholders to prioritize best management practice (BMPs) identified in the 2015 stormwater retrofit reconnaissance survey, as well as the action items that address identified stressors in the watershed.

Figure 1. A Watershed Management Cycle ensures that this plan is a "living document".

To ensure that restoration goals are achieved, the community should consider this plan a "living document". In other words, the goals and objectives of the Goosefare Brook WBMP should be collaboratively revisited and revised on an annual basis by the City of Saco and the Town of Old Orchard Beach (Figure 1).

2 WATERSHED CHARACTERIZATION

2.1 LOCATION & CLIMATE

As one of the most popular destinations for both tourists and local residents, it is especially important to restore Goosefare Brook so that it can support and sustain both recreational and natural ecosystem functions. Historic climate data for Portland Maine was used as representative climate for the Goosefare Brook watershed as it is the nearest large city with a long climatic record (NCDC 2016). Historic temperatures have remained fairly constant with an overall average of 7.6°C (45.7°F). Linear regression analysis reveals that precipitation has increased significantly ($p<0.01$) since the beginning of the record (1940) with an overall average total monthly precipitation of 3.7 inches (Figure 2).

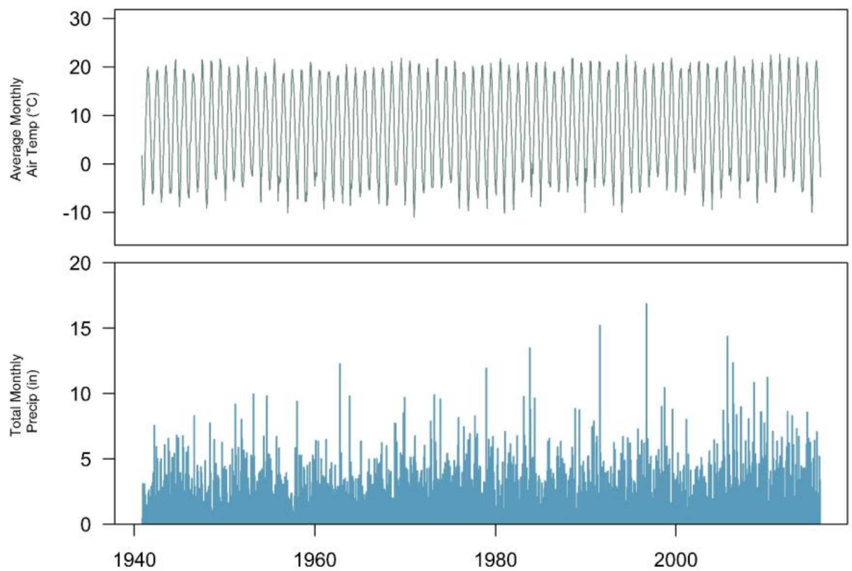


Figure 2. Mean average air temperature (top) and total monthly precipitation (bottom) from 1940 to 2015. Data were obtained from the NOAA National Climate Data Center (NCDC) from the Portland International Jetport station (GHCND:USW00014764).

2.2 POPULATION DEMOGRAPHICS

2.2.1 CITY OF SACO

Census records for the City of Saco date back to 1790 and continue in ten-year intervals through 2010. The minimum population of Saco was 1,350 in 1790 and has grown at a consistent rate to 18,482 in 2010 (Figure 3). The city grew the most between the 1830 and 1840 censuses, with a 36.9% change. The 2010 census revealed a 9.9% increase in growth from 2000 (University of Maine 2012).

Current demographics within the City of Saco place the majority of the population between 45-49 years of age (representing 8.7% of the city's population at 1,608 persons) (Table 1; US Census American Fact Finder 2010).

2.2.2 TOWN OF OLD ORCHARD BEACH

With a population of 8,624 in 2010, the Town of Old Orchard Beach is much smaller than the City of Saco. However, seasonal influxes of tourists vacationing near Old Orchard's seven miles of beach make population dynamics in this town quite variable. Historically, the first recorded population in the Town of Old Orchard was 877 persons in 1890 (however, the Town was established in 1883), the lowest population on record. Old Orchard Beach experienced its greatest population change between the 1940 and 1950 censuses, with an 84.1% increase (Figure 3).

The majority of Old Orchard Beach's population falls between the ages of 20 and 64 (5,633 persons). The population over age 65 is larger than the population under 19, which is responsible for the slightly higher median age of 47.8 years (Table 1; US Census American Fact Finder 2010).

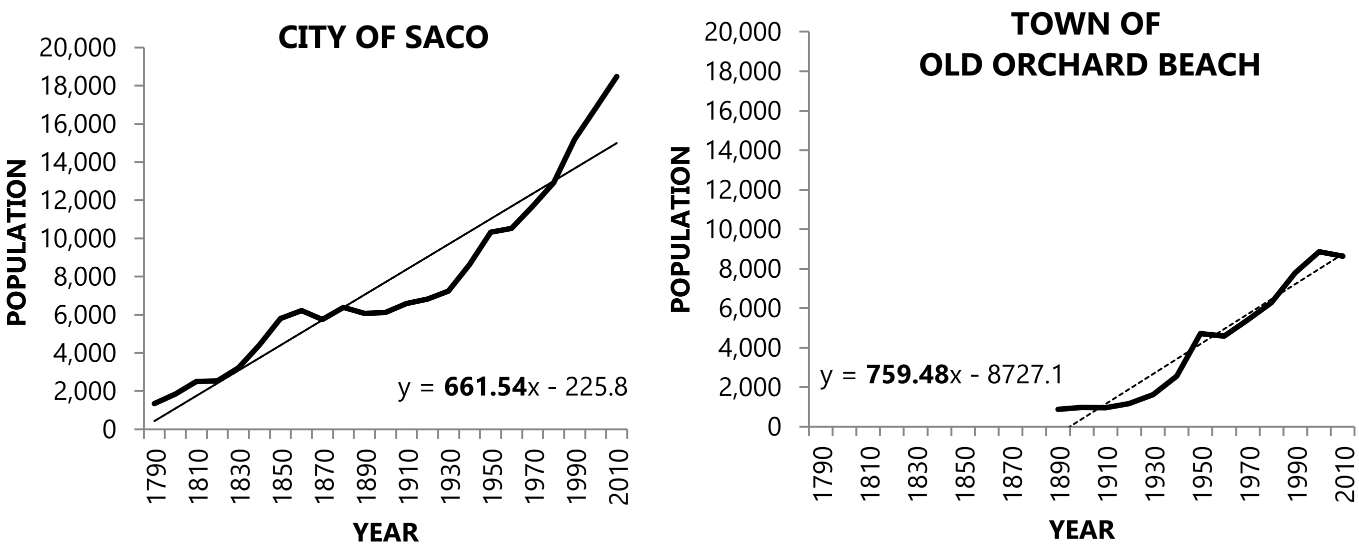


Figure 3. Population and growth trends for the City of Saco (left) and the Town of Old Orchard Beach (right). Note that while the Town of Old Orchard Beach has a greater slope increase, the record is shorter, dating back to only 1890.

Table 1. 2010 population demographics for the City of Saco and the Town of Old Orchard Beach.

MUNICIPALITY	TOTAL POPULATION	POPULATION AGED 0-19	POPULATION AGED 20-64	POPULATION AGED 65+
SACO, ME	18,482	4,443	11,393	2,646
OLD ORCHARD BEACH, ME	8,624	1,360	5,633	1,631

In more recent decades, slower growth has been documented in the State of Maine compared to the national average. Despite this trend, the State of Maine has seen greater growth in the State's metropolitan or urban areas compared to rural areas. Urban service centers in Maine (including Bangor, Portland, Lewiston/Auburn, Augusta, Rockland, Sanford, Ellsworth, and Farmington) account for 87% of total population growth in Maine between 2000 and 2010 (Muskie School of Public Service 2012). Located just south of Portland, population trends in both Saco and Old Orchard Beach follows the same pattern of urban development. The significant historical growth statistics displayed in this section suggest that both municipalities consider the effects of current land-use regulations on local water resources. As the region's watersheds are developed, increases in disturbed and developed areas also increases the potential for water quality decline.

2.3 PHYSICAL FEATURES OF THE WATERSHED

2.3.1 WATERSHED DESCRIPTION

The Goosefare Brook Watershed is approximately 5,902 acres (9.2 sq. mi.) in total size with approximately 4,135 acres in the City of Saco and 1,771 acres in the Town of Old Orchard Beach (inside cover). While Goosefare Brook is the focal stream of this plan, there are four named tributaries within the watershed including Bear Brook, Branch Brook, Innis Brook and Trout as well as many small tributaries. Goosefare Brook becomes a tidal estuary just below Old Orchard Road before entering the Atlantic Ocean. In 2014, the Maine DEP updated the watershed boundary and conducted subwatershed mapping in the freshwater portion of the watershed using precise on the ground and topographic analysis. The Goosefare Brook watershed has been evaluated as a single watershed unit, however, for the remainder of this plan the Goosefare Brook watershed will be presented as a **sixteen** subwatersheds since each has unique water quality conditions, land uses and management recommendations.

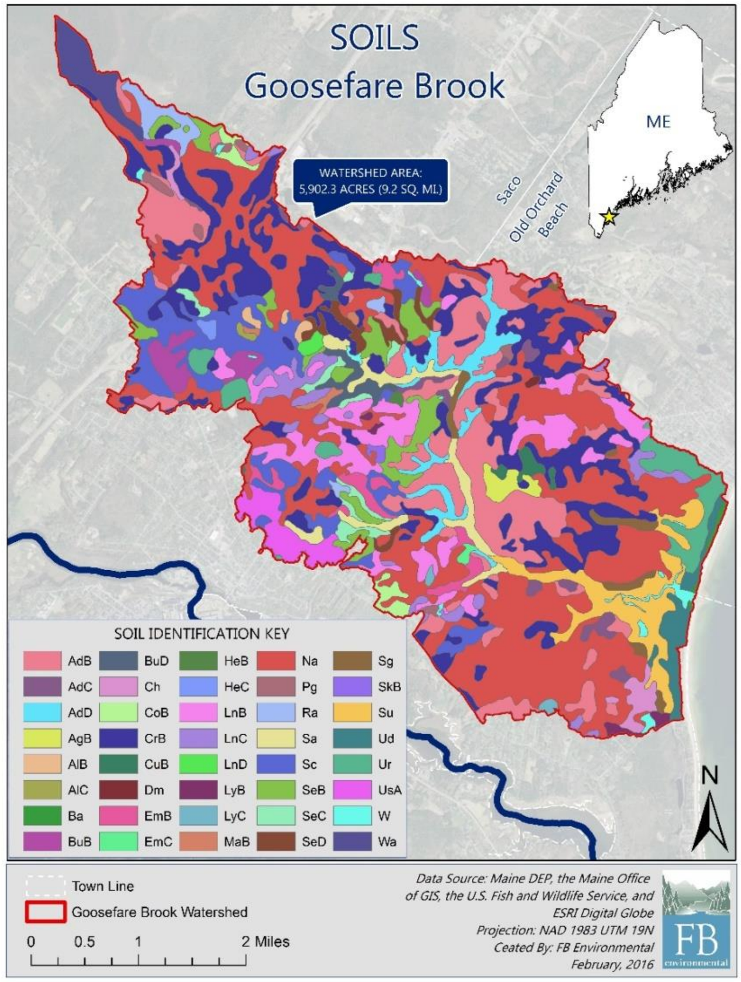
2.3.2 TOPOGRAPHY

Goosefare Brook is situated just north of the Saco River basin along the southern Maine coastline. It flows from its headwaters in the Saco Heath through residential, commercial, and industrial development in both Saco and Old Orchard Beach before it forms a significant estuary just upstream of its outlet to the Atlantic Ocean. The highest point within the watershed is only 140 feet above sea level and is located on the northernmost portion of Jenkins Road within the watershed boundary. Refer to Appendix I, Map B.

2.3.3 SOILS & GEOLOGY

Forty different soil classifications are present in the Goosefare Brook watershed, demonstrating the capability of the watershed to sustain a large diversity of terrestrial and aquatic communities (Appendix I, Map C). Naumburg sand (Na) covers the largest area in the watershed (27.7%). A typical Na pedon (soil unit) is composed of fine loamy sand from glaciofluvial or deltaic sand parent material and is present on small slopes (0-8%) and is characterized as somewhat poorly to poorly drained soil. This soil type is found just inland of the coast where water tables are deeper than the estuarine salt marshes, but they remain in the shallow soil profile. Adams loamy sand (AdB, AdC, AdD), formed in sandy glaciofluvial or glaciolacustrine deposits, comprises 15.3% of the soil in the watershed on slopes ranging from 0-40%. This soil is somewhat excessively drained and is generally located in the uplands of the Goosefare Brook watershed. The third most dominant soil present in the watershed is Croghan loamy sand (CrB) with 15.1% coverage. Croghan loamy sand originates from deltaic or glacial outwash, is moderately well drained with negligible to low surface runoff, and is typically found on slight slopes (2%). The Naumburg sand and Adams loamy sand are known to be in a drainage sequence with Croghan soils (NRCS 2013).

Numerous other soils types are found within the watershed, forming a mosaic of pedons. Some of these additional types include but are not limited by: Scantic silt loam (Sc), Sulfihemists, frequently flooded (Su), Saco mucky silt loam (Sa), and Lyman loam (LnB, LnC, LnD). Many of these soils have water tables that frequently inundate the shallow surface horizons and high organic matter content. These soils appear in the salt marsh and estuarine environment along the coast as well as in areas such as the Saco Heath, where peat deposits have formed. These areas are important for natural flood mitigation and are also sources of organic materials in the water which can bind with metals, potentially precipitating them from solution.



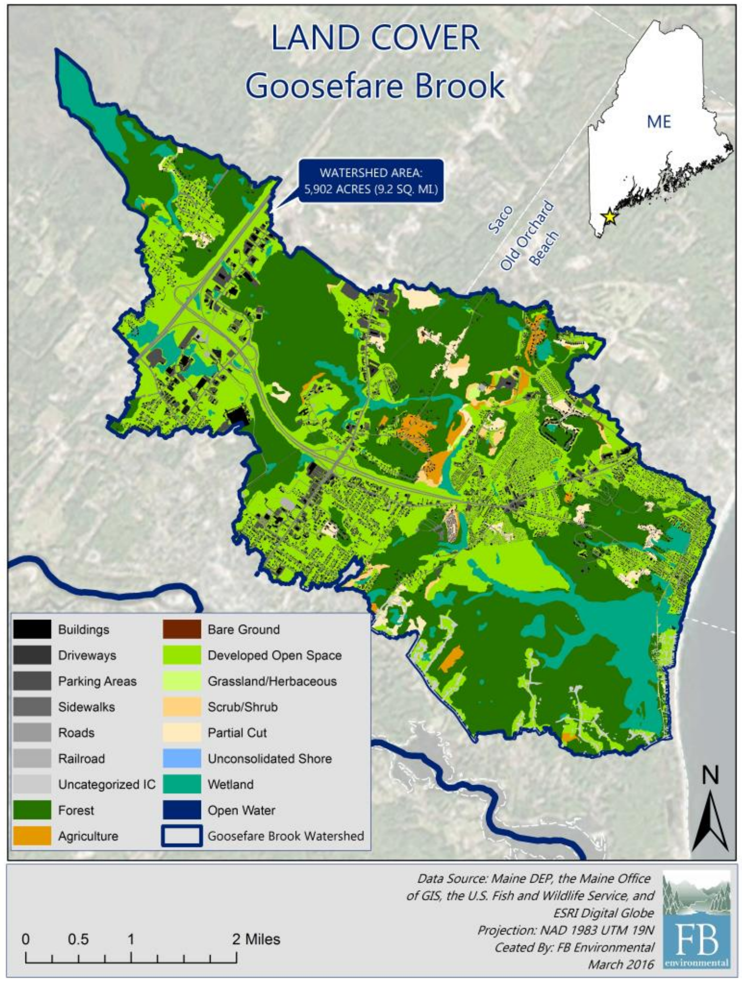
Soils in the Goosefare Brook watershed. Refer to Appendix I, Map C.

The surficial geology of the Goosefare Brook watershed is dominated by marine regressive sand deposits (Pmrs), which comprises 83% of the area. Marine regressive sand deposits are characterized by massive to stratified and cross-stratified, well-sorted sand (Appendix I, Map D). Marine near shore deposits (Pmn) and salt marsh wetlands (Hwsmt) are both present, each comprising approximately 3% of the surficial geology in the watershed. Marine near shore deposits are comprised of sand and gravel formed during marine submergence and regression. Salt marsh wetlands are salt marshes containing peat deposits, but not enough to constitute a significant commercial resource (MDC/MGS 1999).

Additional surficial geology types are present in the watershed but in minimal amounts. These include: End moraine (Pem), swamp wetland (Hwst), and Marine fan (Pmf) (MDC/MGS 1999).

2.3.4 LAND COVER

Land cover in the Goosefare Brook watershed was determined using a combination of land use data from Maine Office of GIS (MEGIS) and the Maine DEP. 2004 land cover data from MEGIS was combined with recent Maine DEP IC polygons (freshwater portion) and MEGIS 2004 IC imagery (estuarine portion) using ESRI® ArcMap software. Maine DEP IC was prioritized because it is the most recent file. National wetland inventory (NWI) wetlands were then added to the map and compared to 2004 land cover wetlands. Wetlands from the 2004 land cover data were converted to either wetlands or mixed forest using ESRI ® base imagery. Parcels from the 2004 land cover data labeled as "High Intensity Development", "Medium Intensity Development", and "Low Intensity Development" that did not intercept the impervious cover file, were converted to "Developed Open Space."

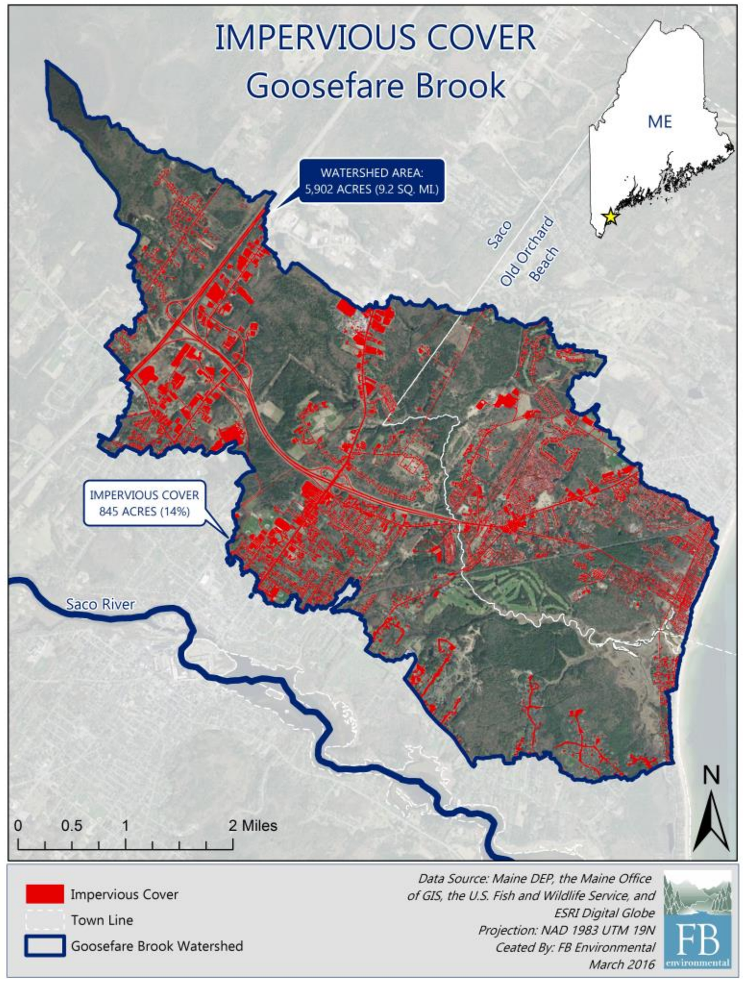


Land cover in the Goosefare Brook watershed. Refer to Appendix I, Map E.

While 17 different land cover types have been differentiated in the Goosefare Brook watershed, three dominate the landscape. Forests, developed open space, and wetlands represent over 80% of the watershed land cover. Forests, including deciduous, evergreen, and mixed habitats, account for approximately 40% of the land cover (2,383 acres). Developed open space, such as lawns, road-shoulder vegetation and other non-extensive habitat green areas, account for the second largest land cover totaling over 1,700 acres or 30% of the watershed and wetland habitat represents just over 10% (604 acres).

Imperviousness of the Goosefare Brook watershed includes buildings, driveways, sidewalks, parking areas, roads, railroads, and other **impervious cover (IC)** (Appendix I, Map F). These categories combined account for approximately 14% of the land cover in the watershed. Buildings, parking areas, and roads each account for between 200-300 acres (3-5% land cover) and are the dominant IC types. As development in the watershed increases, especially commercial development designed to accommodate high traffic volumes, IC typically increases, threatening the capacity of the natural system to sustain large stormwater runoff volumes.

IMPERVIOUS COVER | *Impervious cover refers to any surface that will not allow water to soak into the ground. Examples include paved roads, driveways, parking lots, and roofs.*



The City of Saco has experienced growth in its residential, commercial and industrial sectors over the past few decades. The historically agricultural land found west of the I-95 has seen dramatic increases in residential development (56.5% of population growth), while the downtown has seen a transition from a manufacturing to service-based economy with significant improvements to the Saco mills and Main Street. The Route 1 corridor, which is a focus of this report due to high IC, is zoned for commercial use (Highway Business District B-2) and as such, contains many fast food restaurants and other services (City of Saco 2011). Because this area is zoned for high traffic businesses, it results in high IC and future development is a risk to local waterbodies, such as Goosefare Brook.

Evaluations of future land use trends in Old Orchard Beach are currently being assessed. Preliminary findings suggest that, despite the past recession, development has been increasing within the town. The total number of applications for site plans (single, multifamily homes or large improvements), conditional uses (accessory dwelling units, home occupations, childcare facilities, public and private utility facilities), and subdivisions (both major (5+ subplots) and minor (<4 sub plots)) have been steadily increasing since 2010 (OOB 2013).

A view of the Rachel Carson Wildlife Preserve at the Goosefare Brook estuary. PHOTO CREDIT: FBE.

2.3.5 LAND CONSERVATION

Approximately 665 acres of land in the watershed are conserved. These parcels are owned and managed by a mix of federal, state and municipal entities and nonprofit land trusts and offer public access through an extensive network of trails. In addition to recreational benefits, the properties also provide important wildlife habitat and ecological benefits.

RACHEL CARSON WILDLIFE REFUGE

The Rachel Carson Wildlife Refuge was established in 1966, in cooperation with the State of Maine, to protect salt marsh habitat for migratory birds. It consists of eleven parcels spanning from Cape Elizabeth, ME to Kittery, ME. Approximately 5,000 acres of land are protected by the refuge, and a total of 7,600 acres will be protected when the current land acquisition boundaries are complete. The Goosefare Brook division is one of the eleven parcels, which is within the municipalities of Saco and Old Orchard Beach. Rachel Carson holds a total of 500 acres within the Goosefare Brook watershed.[2]

Views of various conservation parcels in the Goosefare Brook watershed. PHOTO CREDIT: The Nature Conservancy (left), FBE (middle), and SVLT (right).

[2] http://www.fws.gov/refuge/rachel_carson/

SACO HEATH

The Nature Conservancy owns this 1,223-acre preserve that serve as the headwaters to Goosefare Brook as well as other streams in Saco. Saco Heath formed when two adjacent ponds filled with decaying plant material called peat. Eventually, the two ponds filled completely and grew together to form a raised coalesced bog, where the surface of the peat is perched above the level of the groundwater. The preserve features a self-guided hike along a woodland trail to a boardwalk through the heath's varied peatland communities.

BLUEBERRY PLAINS

The Town of Old Orchard Beach owns two parcels on Ross Road comprising Blueberry Plains, at 4.2 and 9.8 acres each. Blueberry Plains is a unique sandy area that supports a wealth of ripe blueberries in August and stands of pitch pines. The property, which has been owned by the town since 1950, has a network of sandy trails that extend close to Trout Brook, which is a high-quality tributary of Goosefare Brook.

SACO VALLEY LAND TRUST

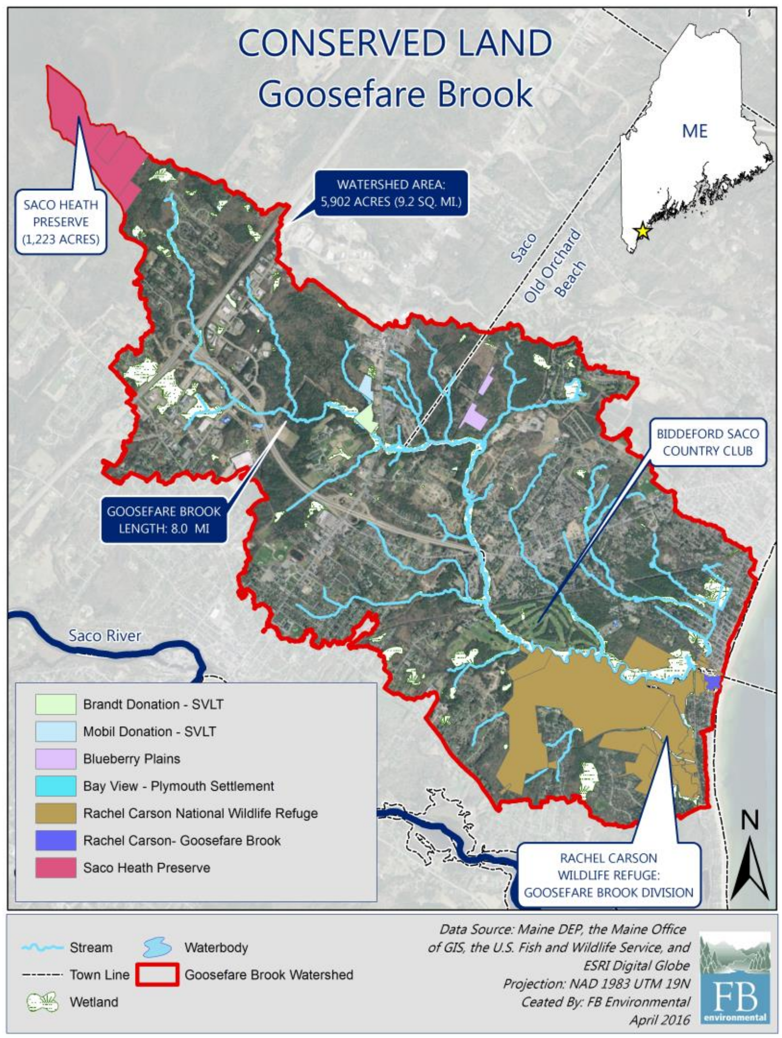
The SVLT owns two parcels of land in close proximity to Goosefare Brook[3]. These areas include

- **Mobil Donation:** The Mobil Donation is 6.3 acres in area and is located behind the Mobil Station on Route 1 (i.e. Portland Road). As part of the Saco Bay Trails Network, there are trails and signage located on the parcel. These trails also connect it to the Brandt Donation.

- **Brandt Donation:** The Brandt parcel is located off Route 1, (i.e. Portland Road). It is a wooded 7.5 acres that contains groomed paths and an overlook of a marsh and Goosefare Brook. The overlook can be found behind the Mobil Station on Route 1.

BAY VIEW – PLYMOUTH SETTLEMENT

This 2.8 acre parcel is located in the southeastern corner of the watershed and is a conservation easement held by the Maine



Conserved land in the Goosefare Brook watershed. Refer to Appendix I, Map G.

[3] *www.sacovalleylandtrust.org*

Department of Inland Fisheries and Wildlife (Maine IF&W). It is designated as a Wildwood Deer Wintering Area (MEGIS 2016).

2.3.6 STORMWATER AND SEWER INFRASTRUCTURE

The stormwater system is largely concentrated within the commercial development located around the Route 1 corridor in Saco as well as along Saco Avenue through Old Orchard Beach (see Appendix I, Map H). Stormwater catch basins and pipes line this commercial area, with some existing stormwater treatment in some areas. These areas have little current treatment practices for water retention and filtration. While these existing stormwater treatments are important, the Goosefare Brook watershed needs more BMPs to handle the large amount of runoff that flows directly to the stream from buildings, parking lots and roads. Furthermore, the sewer infrastructure within both municipalities is aging and therefore requires constant maintenance and inspection.

- The City of Saco Stormwater and Sewer Systems: The majority of buildings in the Goosefare Brook watershed are serviced by City sewer as a means of human waste disposal. However, some rural lots in close proximity to Goosefare Brook along Jenkins Road, Moody Street, and Woodman Avenue still rely on private septic systems. Other private septic systems are concentrated primarily west of interstate I-95.
- The Town of Old Orchard Beach Stormwater and Sewer Systems: Similar to the City of Saco, the Old Orchard Beach stormwater system is centralized around the downtown and coastal beach community. Originally, the town's sewer treatment plant outfall discharged into Goosefare Brook. However, the outfall now extends 3,100 feet offshore of Goosefare Brook in 20 feet of water at low tide. Zoning restrictions encourage smaller properties along the beach to connect to the centralized sewer system. However, private septic systems do exist in this area. These septic systems must be maintained and inspected regularly to prevent waste contamination into both Goosefare Brook and the ocean.

3 WATER QUALITY

3.1 CAUSES OF IMPAIRMENT

The State of Maine, in accordance with the Federal Clean Water Act, has established minimum standards that all streams must meet. Most of Goosefare Brook is classified as a Class B water, meaning the Brook must meet Class B stream standards as defined under Maine's Water Classification Program as established by the Maine Legislature (Title 38 MRSA 464-468). The Maine Legislature has established that "*Class B waters shall be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life*". Table 2 summarizes the narrative and numeric water quality standards applicable to the Goosefare Brook watershed.

Table 2. **Maine water quality criteria for Class B freshwater streams (38 MRSA § 465).**

PARAMETER	CRITERIA FOR COMPLIANCE
Designated Uses	Water must be suitable for drinking water supply after treatment; fishing; agriculture; recreation in and on the water, industrial process and cooling water supply; hydroelectric power generation; an un-impaired habitat for fish and other aquatic life.
Dissolved Oxygen *Year-Round*	May not be less than 7 ppm or 75% saturation, whichever is higher.
Dissolved Oxygen *October 1st – May 15th*	In order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean dissolved oxygen concentration may not be less than 9.5 ppm and the 1-day minimum dissolved oxygen concentration may not be less than 8 ppm in identified fish spawning areas.
E. coli	Between May 15th and September 30th, the number of Escherichia coli bacteria in these waters may not exceed a geometric mean of 64 per 100 milliliters or an instantaneous level of 236 per milliliters.
Discharges	Must not cause adverse impact to aquatic life, and the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

In addition to the freshwater standards, marine Class SB standards apply to Goosefare Bay and the estuarine section of Goosefare Brook from the head of tide to the former treatment plant outfall. The segment of Goosefare Brook from the former treatment plant outfall to the ocean is Class SC. Dissolved oxygen content of Class SB waters must be not less than 85% of saturation. Also, between May 15th and September 30th, the numbers of *Enterococcus* bacteria of human and domestic animal origin in these waters may not exceed a geometric mean of 8 per 100 milliliters or an instantaneous level of 54 per 100 milliliters. Class SB criteria calls for DO saturation above 70% and *Enterococcus* geometric mean above 14 per 100 milliliters or an instantaneous level of 94 per 100 milliliters.

Goosefare Brook was first listed as impaired following a total maximum daily load (TMDL) written in 2003 (Maine DEP 2003) addressing seven heavy metals (Cadmium, Chromium, Copper, Iron, Nickel, Lead, Zinc). The Maine Statewide Bacteria TMDL (2009) also listed Bear Brook (a tributary to Goosefare Brook) as impaired for *Escherichia coli* (*E. coli*). In 2011, additional monitoring caused

Goosefare Brook itself to be added to the TMDL for bacteria impairments and was included in the 2014 Maine Bacteria TMDL (Maine DEP 2014). Additionally, Goosefare Brook was listed on the 2012 impervious cover TMDL for impairments to aquatic life use (benthic-macroinvertebrate and stream habitat assessments) (Maine DEP 2012). The estuarine section of Goosefare Brook below the former WWTP outfall is also listed as impaired for marine life support due to DO. However, the listing noted that this impairment was expected to improve since the outfall was removed. Although this plan does not focus on Goosefare Bay, this marine area is designated Class SC, and it is listed as impaired for elevated fecals.

3.1.1 AQUATIC LIFE IMPAIRMENT

The DEP's Biological Monitoring program collects and analyzes aquatic macroinvertebrate samples to make aquatic life determinations for freshwater streams and rivers. The program uses the resulting data and a statistical model to determine if a stream meets its statutory classification. This model takes into account the abundance and diversity of macroinvertebrate species found at that site during baseflow (i.e. stressed) periods. Seven biomonitoring stations have been assessed on Goosefare Brook over the past 31 years, and this data indicates that Goosefare Brook does not meet Class B standards. Although there is only one year of biomonitoring data for one site on Bear Brook, sampling in 2014 showed that this stream is also likely impaired for Class B aquatic life standards. At least one more year of year of biomonitoring would be needed prior to a formal impairment listing. 2015 results are not yet available.

3.1.2 DISSOLVED OXYGEN IMPAIRMENT

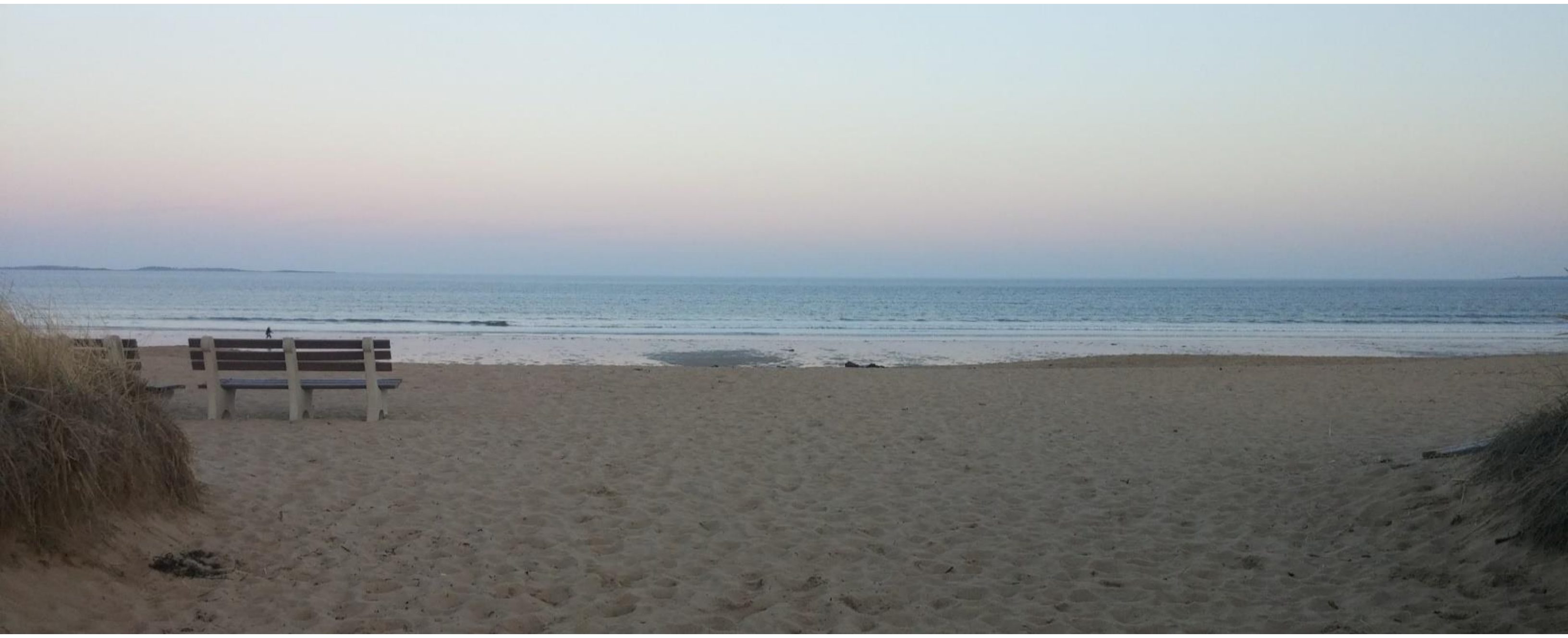
Goosefare Brook is officially listed for dissolved oxygen (DO) impairment only in the estuarine section. However, recent monitoring through the WBMP planning indicates that there are also several freshwater areas that do not meet Class B standards. As discussed in subsequent sections, low DO appears to be a potential reason for this aquatic life impairment in some parts of the watershed.

DO is the concentration of oxygen dissolved in the water that is available for aquatic organisms and macrophytes. It is measured in mg/L, equivalent to parts per million (ppm). DO facilitates critical chemical reactions in the stream that support life processes and functions. Depletion of available oxygen (known as hypoxia or anoxia) inhibits physiological functioning of aquatic life and its persistence can reduce the diversity and abundance of biota. DO fluctuates naturally on a diurnal basis depending on a suite of interactions and resource availability (e.g. light, nutrients, organic matter, temperature, etc.). DO is often highest during the day when sunlight drives photosynthesis (produces oxygen), while DO is often lowest at night when autotrophic respiration and decomposition of organic matter dominates (consumes oxygen). The Maine DEP uses diurnal swings > 2 ppm as an indicator of highly productive streams with nutrient enrichment. For Class B streams, the State of Maine and the U.S. Environmental Protection Agency (USEPA) sets a numeric criterion for DO at 7 ppm from May 15 to September 30. From October 1 to May 14, daily mean DO must be greater than 8 ppm and the 7-day mean must be at least 9.5 ppm (Table 2).

3.1.3 BACTERIA IMPAIRMENT

High concentrations of fecal indicator bacteria in waterbodies can lead to posted advisories at swimming beaches and closures of shellfish beds. These bacteria are used to signal human health risks such as gastrointestinal, respiratory, eye, ear, nose, throat, and skin infections transmissible to humans through consumption of contaminated fish and shellfish, skin contact, and/or ingestion of water.

Bacteria are present in the intestinal tracts of warm-blooded animals and are used to indicate the presence of fecal contamination in waterbodies. Each gram of human feces contains approximately 12 billion bacteria, many associated with human health issues. Feces from other warm-blooded animals, including pets, farm animals, and wildlife may also contribute bacteria and associated disease vectors to waterbodies. ***E. coli*** bacteria are used by the State of Maine to assess the designated uses for freshwater streams, rivers and lakes. Currently, both Bear Brook and Goosefare Brook are listed as impaired for *E. coli*. ***Enterococcus*** bacteria are used to assess the designated uses for estuarine and marine waters. It is also used to determine the need for closings and



Old Orchard Beach, pictured above, is sampled by Maine Healthy Beaches to test for fecal bacteria that might lead to summer beach closures. PHOTO CREDIT: FBE

advisories at coastal beaches. Significant efforts have been made by the Town of Old Orchard Beach, the Old Orchard Beach Conservation Commission, the Ocean Park Conservation Society, and Maine Healthy Beaches to monitor and identify sources of *Enterococcus* bacteria in the Goosefare Brook estuary and beaches. However, bacteria counts continue to be elevated to levels that lead to posting swimming advisories at beaches. The Ocean Park area within Old Orchard Beach is closed for shellfish harvesting due to the sewer outfall offshore.

3.1.4 TOXIC METAL IMPAIRMENT

Metals occur at natural levels within aquatic environments; however, when metals are present in large concentrations they may affect the behavior, reproduction, and overall survival of aquatic organisms. Maine Statewide Water Quality Criteria (SWQC) for metals are listed in Table 3 and are based on a hardness standard of 20 mg/L (Maine DEP 2003). Criteria Chronic Concentration (CCC) and Criteria Maximum Concentration(CMC) levels are both designated for the following metals: Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Nickel (Ni), Lead (Pb), and Zinc (Zn) (Table 3). The 2003 Maine DEP TMDL for Goosefare Brook attributed high levels of heavy metals to a detention pond from the former Saco Steel

> ***Escherichia coli* (*E. coli*)** and ***Enterococcus*** *are bacteria present in the intestinal tracts of warm-blooded animals and are used to indicate the presence of fecal contamination in waterbodies.*

industrial facility. Heavy metals below the Saco Steel facility were found to be up to four times higher than sampling sites above this site (Maine DEP 2003).

Table 3. Maine SWQC for seven metals of interest. CCC = Criteria Chronic Concentration; CMC = Criteria Maximum Concentration.

	Cd	Cr	Cu	Fe	Ni	Pb	Zn
Criteria-Type (ppm or mg/L)							
CCC	0.000321	0.0554	0.00299	1	0.0404	0.00041	0.0271
CMC	0.000638	*	0.00389	NC	0.3634	0.010523	0.0299

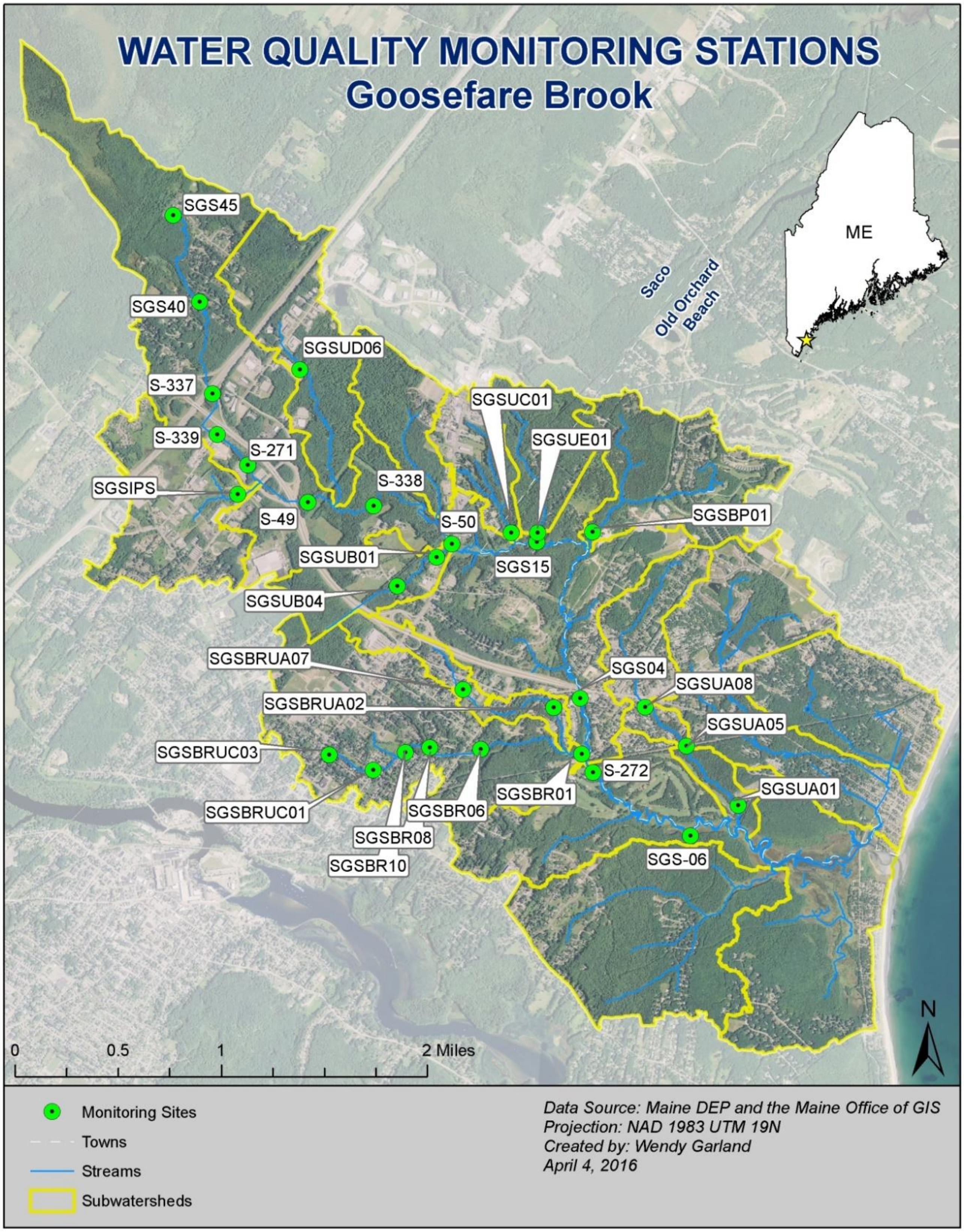
**complex, see Maine DEP's Gold Book*
NC = No Criteria

3.2 WATER QUALITY AND ECOLOGICAL HISTORY

The sections below outline all historical water quality monitoring and data available for Goosefare Brook and its tributaries. A comprehensive site map with all DEP monitoring locations can be found on the following page. Table 4 below provides a comprehensive summary of the water quality found in the Goosefare Brook watershed. It is broken down by subwatershed and further by specific sites within subwatersheds when necessary to highlight variations in the water quality. Due to limited spatial extent, data regarding macroinvertebrate assessments, toxics, pH, nutrients, and fish are not included in this table and are discussed in more detail in the following sections.

Table 4. An overview of water quality in the Goosefare Brook watershed by subwatershed. Red text denotes poor water quality for the parameter listed.

Subwatershed	Dissolved Oxygen	Diurnal DO Swings	Chloride and SpC	Temperature	Bacteria
Bear Brook N. Branch - Coolidge	Adequate	Very Low	**Very High**	Good	**Very High**
Bear Brook N. Branch - Ocean Park	Good	Very Low	**High**	Good	**High**
Bear Brook South Branch	**Poor**	**Large**	Mod. High	Good	**Very High**
Branch Brook	-	-	Low	Good	-
IMAX Stream	Very Good	-	Very Low	Very Good	Good
Industrial Park North	Adequate	Very Low	**Very High**	Good	**Very High**
Industrial Park South	Adequate	**Large**	**Very High**	**Warm**	-
Innis Brook	Very Good	-	Low	Good	Good
Lower Main Stem - Ross Rd	**Poor**	**Mod. High**	Mod. High	Good	**Mod. High**
Lower Main Stem - Ocean Park Rd.	Adequate	Low	Mod. High	Good	**Mod. High**
Lower Main Stem - Old Orchard Rd	**Poor**	**Mod. High**	Mod. High	Good	**Mod. High**
Moody Street Stream	Adequate	Very Low	**Very High**	Good	Mixed
New Salt Road Tributary East Branch	-	-	-	-	**Very High**
New Salt Road Tributary West Branch	-	-	Low	-	**High**
Old Salt Road Tributary	Adequate	**Large**	Mod. High	Good	-
Route 1 North	Good	-	**High**	Good	-
Tidal Main Stem	-	**Large**	-	-	-
Trout Brook	Very Good	Very Low	Mod. High	Very Good	Very Low
Upper Main Stem - Park and Ride	Adequate	Very Low	**High**	Good	Low
Upper Main Stem - Jenkins	Very Good	Very Low	Low	Good	Low


WATER QUALITY MONITORING STATIONS
Goosefare Brook
ME
Saco
Old Orchard Beach
SGS45
SGS40
SGSUD06
S-337
S-339
S-271
SGSIPS
S-49
S-338
S-50
SGSUC01
SGSUE01
SGSBP01
SGSUB01
SGS15
SGSUB04
SGSBRUA07
SGS04
SGSUA08
SGSBRUA02
SGSUA05
SGSBRUC03
S-272
SGSBR01
SGSUA01
SGSBRUC01
SGSBR06
SGSBR08
SGSBR10
SGS-06
N
0
0.5
1
2 Miles
Monitoring Sites
Towns
Streams
Subwatersheds
Data Source: Maine DEP and the Maine Office of GIS
Projection: NAD 1983 UTM 19N
Created by: Wendy Garland
April 4, 2016

3.2.1 BIOLOGICAL ASSESSMENTS

Macroinvertebrates are aquatic insects, including mayflies, dragonfly larvae, caddisfly larvae, aquatic worms, amphipods, leeches, clams, and snails, that live on stream bottom substrates, such as rocks, logs, sediment, and plants. They serve as excellent indicators of water quality, depending on the amount and type of species present and their associated pollutant tolerances. EPT is an index of three orders of aquatic insects: *Ephemeroptera* (Mayflies), *Plecoptera* (Stoneflies), and *Trichoptera* (Caddisflies). These taxa are generally intolerant of pollutants and are found in less impacted, oligotrophic streams. *Chironomidae* (midges) are more tolerant of pollutants and are found in greater abundances in eutrophic streams.

Protocols for sampling and analysis of macroinvertebrate surveys include deploying rock bags on the stream bottom for approximately four weeks, which allows macroinvertebrates enough time to colonize the rocks (Maine DEP 2011). Bags are collected along with physical data (water velocity, dissolved oxygen, temperature, conductivity, description of substrate and site). The macroinvertebrate communities within the rock bags are separated and identified by lowest taxonomic group (genus or species). This generates data on the abundance and generic richness of the macroinvertebrate community present within the stream, which are then analyzed and used in a statistical model to determine whether a stream meets its designated standards.

Macroinvertebrate surveys have been conducted at eight sites in Goosefare Brook, across 31 years (Appendix II, Table 1). The site sampled for the longest period of time, S-48, was sampled in nine different years from 1984 to 2015. S-48 is the most upstream macroinvertebrate site, located in an area of low residential development off Jenkins Road. This site met Class A standards in 1984, 1986, and 1994 before dropping to Class C abruptly in 1995. However, it reached Class B in 1998 and A again in 2000. Most recently, it has only met Class C in both 2005 and 2010, with a significant decrease in both abundance and diversity. The newest sites, S-1041 (on Bear Brook) and S-1065, have only been monitored in 2014 (S-1041) and 2015 (S-1041 and S-1065). Site S-337 located downstream of S-48 and below the I-95 turnpike met attainment in 1998 and 2005; however, it was non-attaining in 2000, the same year that the upstream site S-48 reached Class A. Site S-271 is the last site to have a history including attainment, meeting Class A in 2005.

DEFINITIONS

Total Mean Abundance: a count of all individuals in all replicate samples from a single site divided by the number of replicates.

Generic Richness: a count of the number of different genera found in all replicates from one site.

Relative Chironomidae Abundance: a count of all individuals from the order Chironomidae in all replicate samples from a single site divided by the number of replicates, and then divided again by the total mean abundance.

EPT Generic Richness: a count of the number of different genera from the order *Ephemeroptera* (E), *Plecoptera* (P), and *Trichoptera* (T) in all replicate samples.

Definitions extracted directly from **Appendix C-1: Methods for the Calculation of Indices and Measures of Community Structure Used in the Linear Discriminant Models from Methods for Biological Sampling and Analysis of Maine's Rivers and Brooks (ME DEP LW0387-B2002).*

A dragonfly larvae found in Goosefare Brook. PHOTO CREDIT: FBE.

All other monitoring years at Site S-271 have not met attainment, primarily due to exceptionally low abundance. The remaining five downstream sites have not met attainment in all of the years sampled. Total abundance decreases downstream until a high abundance is seen at the furthest downstream site (S-272) above the golf course. At this site, total abundance is greater than 400 in both 1995 and 2014, indicating that the lower diversity is responsible for only Class C attainment. Only one year of monitoring is available on Bear Brook (S-1041), however, this monitoring site suggests that aquatic life impairments exist on this tributary as well. Future monitoring is needed to confirm this speculation. 2015 data is not yet available.

Biomonitoring by the Maine DEP is generally conducted on a five-year rotation. According to the Maine DEP Biomonitoring Protocols, macroinvertebrate communities must meet water quality standards for two consecutive sampling events within a ten-year period for the stream to be considered attaining for aquatic life.

3.2.2 DISSOLVED OXYGEN

Dissolved oxygen is the concentration of oxygen dissolved in the water that is available for aquatic organisms and macrophytes. It is measured in mg/L, equivalent to parts per million (ppm). DO facilitates critical chemical reactions within the stream that support life processes and functions. Depletion of available oxygen inhibits physiological functioning of aquatic life and its persistence can reduce the diversity and abundance of biota. DO fluctuates naturally on a diurnal basis depending on a suite of interactions and resource availability (e.g. light, nutrients, organic matter, temperature, etc.). DO is often highest during the day when sunlight drives photosynthesis (produces oxygen), while DO is often lowest at night when autotrophic respiration and decomposition of organic matter dominates (consumes oxygen). The Maine DEP uses diurnal swings > 2 ppm as an indicator of nutrient enrichment. The State of Maine and EPA sets a numeric criterion for DO at 7 ppm and 75% saturation for Class B freshwater streams and 70% saturation for Class SC estuarine waters from May 15 to September 30.

Theresa Galvin of York County SWCD conducting a monitoring visit at Goosefare Brook. PHOTO CREDIT: Maine DEP

Maine DEP deployed continuous data loggers at several stations[4] for two to four weeks periods in the summers of 2013, 2014 and 2015. These instruments recorded dissolved oxygen and temperature reading every 15 minutes. The data were analyzed to look for places where DO dropped below the Class B standard of 7 mg/L or 75% saturation for freshwater stations and below the Class SB standards of 85% saturation for tidal stations. For both freshwater and tidal stations, data were screened for diurnal (daily) swings greater than 2 mg/L, which can indicate areas with excess algae growth and nutrient enrichment.

Most stations were above or near DO standards; however, three stations consistently fell below the acceptable levels during summer baseflow periods. The station on Bear Brook (SGSBR01) showed the lowest DO levels with daily lows in 2013 between 4.5 and 5.5 mg/L (Figure 4). Goosefare Brook at Old Orchard Road (S-272), just below the Bear Brook station, and Goosefare Brook at the Ross Road station (SGS15) also frequently fell below the Class B standard in 2013. Continuous

[4] Four stations in 2013, six stations in 2014 and 2015.

monitoring in 2014 revealed DO below the standard consistently for Bear Brook and occasionally at the Old Orchard Road station (Figure 5).

Most monitoring stations exhibited small diurnal DO swings (<1 mg/L); however, large diurnal swings were observed at seven monitoring stations (Appendix II, Figures 1 & 2). The largest swings (over 3-5 mg/L) were observed in Bear Brook (SGSBR01). Diurnal swings near or above 2 mg/L were also observed at the Old Salt Road Tributary (SGSUA01) and Industrial Park Road South Tributary (SGSIPS), as well at Goosefare Brook at Ross Road (SGS15), Ocean Park Road (SGS04), Old Orchard Road (S-272) and Rachel Carson (SGS-06).

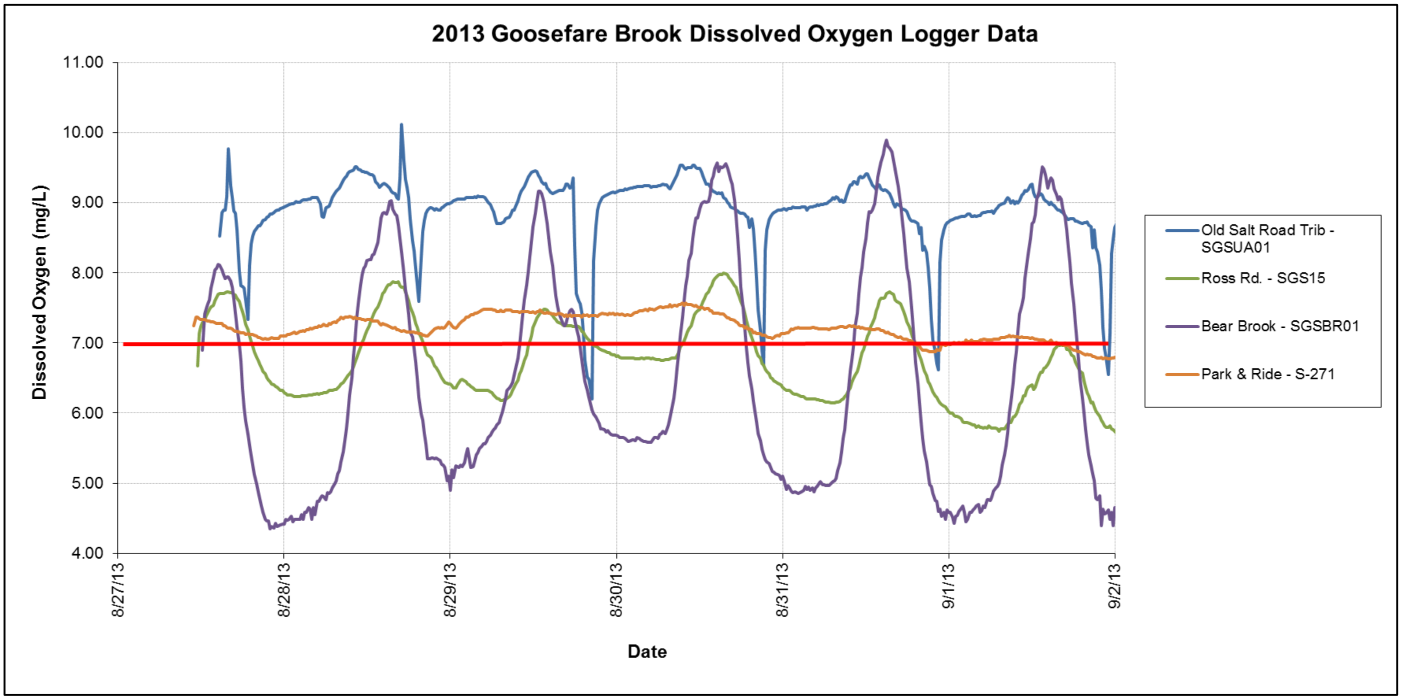


Figure 4. Dissolved Oxygen Data from 2013.

In addition to data collected by the Maine DEP, YCSWCD collected diurnal DO data from eight locations in the summers of 2014 and 2015. Samples were collected three times in August and once in September of 2014 and five times in July and once in August of 2015. Measurements were taken twice a day for each collection, first between 6 and 8 am and again between 1 and 3 pm. Parameters measured included temperature, dissolved oxygen, and specific conductance.

Diurnal DO readings for 2014 ranged from a low of 5.5 mg/L to a high of 8.7 mg/L. Similarly in 2015 readings ranged from 5.3 to 8.4 mg/L across all samples.

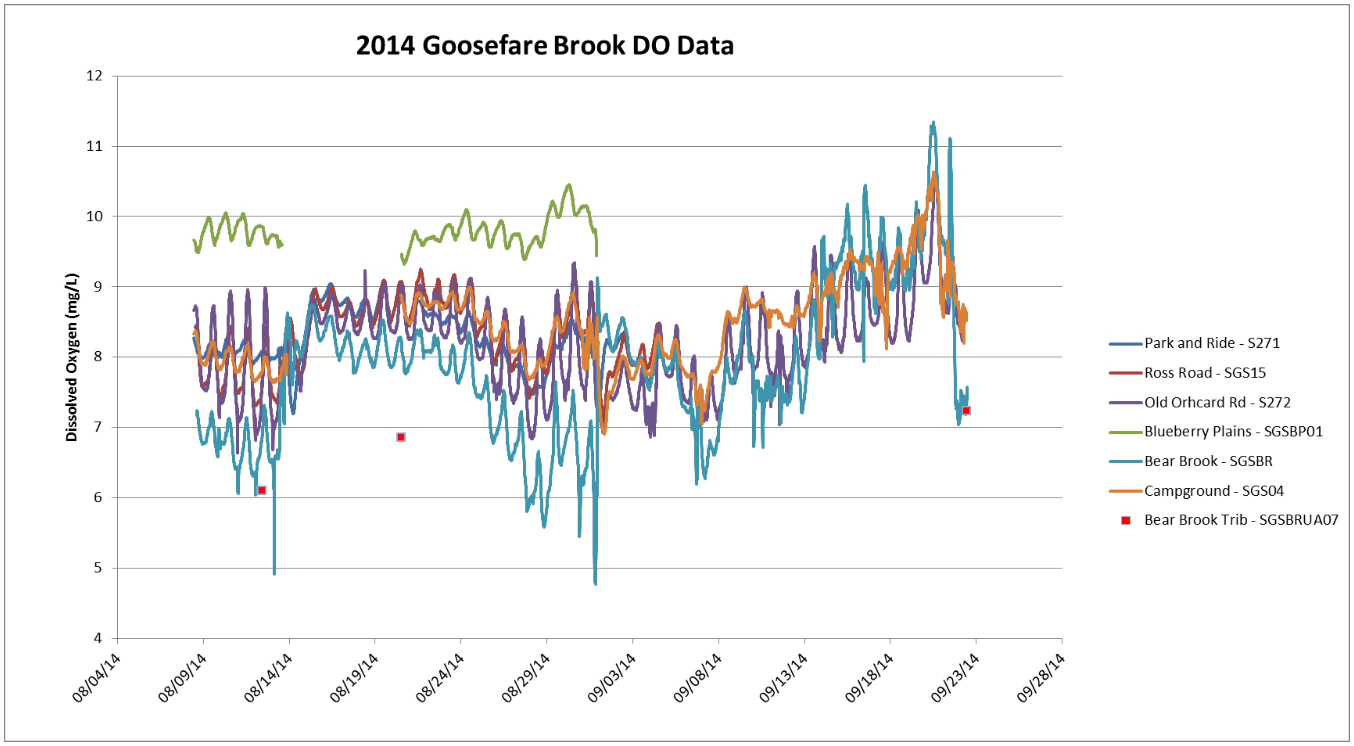


Figure 5. Dissolved Oxygen Data from 2014.

3.2.3 SPECIFIC CONDUCTIVITY AND CHLORIDE

Specific conductivity (SpC) is measured dissolved ions within a parcel of water, including Ca^{2+}, Na^{+}, K^{+}, Mg^{2+}, Cl^{-}, NO_3^{-}, SO_4^{2}. Many of these ions are weathering products and reflect differences in parent geology. In many urban watersheds, chloride, and thus specific conductivity, is of primary interest to management because it represents a large anthropogenic source of pollutants from road salt, septic systems, wastewater treatment plants, and stormwater runoff.

High chloride concentrations in streams and groundwater can be toxic to aquatic life and human health. The Maine DEP sets a standard of a mean 1-hour (acute) exposure of 860 mg/L for chloride and a mean 4-day (chronic) exposure of 230 mg/L for chloride (DEP 06-096 Chapter 584). Any chloride results greater than these standards are considered toxic to aquatic life. This standard does not directly apply to specific conductivity since it represents other elements in addition to chloride, but a relationship for converting specific conductivity to chloride can be easily done.

In 2015, the Maine DEP measured both SpC and chloride from water samples taken at two stations along Goosefare Brook to identify if SpC and chloride adhered to the chloride-conductivity relationship established for other Southern Maine streams. On September 8, 2015, DEP staff measured a SpC of 860 µs/cm in Goosefare Brook (S-271) and laboratory analysis found the associated water sample to have a chloride level of 240 mg/L. Furthermore, a SpC of 256 µs/cm (SGSBRUA07) was correlated with 54 mg/L measured chloride which follows the established curve and indicates that SpC values over 800 µs/cm are approaching toxic levels (Figure 6).

Continuous data loggers deployed by the Maine DEP collected data on SpC at several sites in 2014 and 2015. The SpC values showed wide variation in the watershed. Only one station, Goosefare Brook at Bruno Circle (SGS45), corresponded to natural background levels (< 100 µs/cm). Monitoring stations in five subwatersheds showed only slightly elevated SpC (150-350 µs/cm). These locations were located downstream from areas with fewer roads and development.

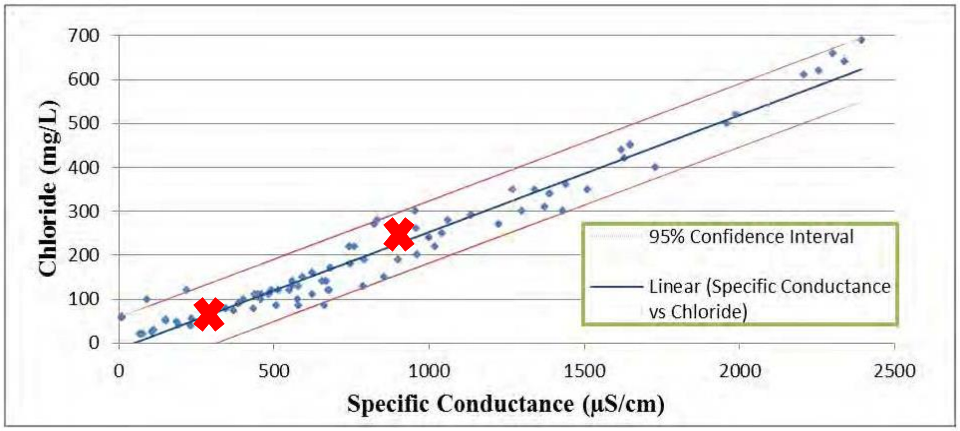


Figure 6. The specific conductance versus chloride relationship created from the Long Creek Watershed aggregate data. Red 'x' indicate where Goosefare Brook samples fall. SOURCE: Long Creek Annual Monitoring Report June 2010 to November 2011.

Several subwatersheds included monitoring stations with relatively high SpC (500-700 µs/cm) or very high SpC (>700 µs/cm). Stations on the Moody Street tributary (SGSUB01), Industrial Park North (SGSUD06) and South (SGSIPS) tributaries, and Bear Brook North (SGSBRUA07) tributary commonly recorded SpC values exceeding the chloride CCC standard. In 2015, the Maine DEP conducted Stream Corridor Assessment (SCA) stream surveys along each of these tributaries (except Industrial Park South tributary). During the survey, they collected SpC data at frequent intervals to help identify potential chloride source areas. Bear Brook and the upper sections of Goosefare Brook (between the S-271 and SGS15) had elevated SpC, but usually remained below the CCC standard.

Specific conductivity was also measured by DEP as part of the 2011 and 2012 Bacteria TMDL study. These earlier monitoring data were similar to the 2014 and 2015 findings, however, the TMDL study found elevated SpC levels at the mouth of the Route 1 North tributary (SGSUE01). During this sampling season, three of the four readings during baseflow conditions were above 700 µs/cm (87, 863, 792, and 733 µs/cm), indicating that there is likely chloride groundwater contamination.

3.2.4 TOXICS

Toxics is a broad term, referring to pollutants that are listed under section 307(a)(1) of the USEPA Clean Water Act. This list includes but is not limited to; heavy metals, petroleum, polycyclic-aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and chlorinated solvents (USEPA 1997). The State of Maine Surface Waters Toxics Control Program (Chapter 530) states that "*Toxic compounds may not be discharged in amounts that may cause toxic impacts on aquatic organisms or effect human health*" (Maine Surface Water Toxics Control Program 2012). Toxic pollutants can disrupt biological functioning of aquatic organisms and therefore, are monitored under the Maine SWQC.

In addition to chloride toxicity from road salt and pH, which are discussed in sections 3.2.3 and 3.2.5 respectively; heavy metals, petroleum, PAHs, PCBs, and chlorinated solvents have been identified as contaminants of concern for the upper portions of Goosefare Brook. The focus for these land use sources centers around two facilities: Saco Steel and the General Dynamics Armament and Technical Products Operation in Saco (previously known as Saco Defense Inc.).

Specific areas of the Saco Steel property were impacted by historic site operations associated with the former scrap metal sorting, processing, and recycling facility. Considerable site cleanup was performed at the Saco Steel site including hazardous material removal, soil removal, soil consolidation and capping onsite, soil cover systems (asphalt, concrete) and control of site stormwater. A stormwater detention pond, which receives runoff from the property, is located adjacent to and drains into Goosefare Brook. Contaminants of concern associated with the Saco Steel site are metals (Cu, Zn, Pb, Cd), PCBs, PAHs and petroleum. Metals identified as present in Goosefare Brook sediments are Fe, Ni, Cu, Cd, Cr, Zn and Pb (Maine DEP 2003). PCBs have also been documented in soils and detention pond.

Prior to be acquired by General Dynamics OTS, Inc. in 2000, the Saco Defense Inc. manufacturing facility operated an unlined surface impoundment containing oily waste and solvent waste from 1970-1983. The primary focus of investigations conducted at the Saco Defense site has been an extensive chlorinated solvent plume that follows a bedrock trough from the source area at Saco Defense to a likely discharge point at the wetland/Goosefare Brook located east of the site. Significant remediation work has been performed at the site in recent years including a pump and treat system that cut off the migration of contaminants in the groundwater at the toe of the plume. The leading edge of the plume flows beneath Goosefare Brook and surfaces as a seep in a wooded area east of the I-195 Connector. Water quality of the intercepted plume, 60 (sixty) other monitoring wells and seep is conducted semi-annually. Chromium and Pb (lead) have also been detected in site groundwater. Flow from this plume has been intercepted and treated for many years. Another possible contaminant pathway from the Saco Defense site is a drainage ditch, which reportedly drains storm water and surface runoff from the onsite lined surface impoundment area to a discharge point feeding into Goosefare Brook. Current monitoring data indicates that contaminants in groundwater are clearly delineated and controlled.

In addition to Saco Steel and Saco Defense, highway runoff is also a potential source of toxic contamination to this upper section of Goosefare Brook. Goosefare Brook flows under the Maine Turnpike Exit 36 interchange and flows just to the west of the Route 195 connector, within the project area. In addition to road salt, petroleum products and PAHs are potential contaminants of concern. A significant petroleum release occurred at Exit 36 (formerly Exit 5) in 2000 when a fuel tank truck rolled over at the exit and discharged approximately 11,000 gallons of gasoline. Cleanup was completed, but residual petroleum contamination has been detected in area soils as late as 2008. The groundwater and soils in the Goosefare Brook watershed are hydrologically connected to the surface water and can deliver these toxic contaminants to the stream.

Past studies of both Saco Steel and Saco Defense properties have been primarily focused on on-site soil and groundwater remediation, with limited investigations about the delivery of contaminants to Goosefare Brook. After reviewing data gaps, the Maine DEP Bureau of Remediation staff enlisted the USEPA for assistance with a Phase I screening of the area. The USEPA and its consultant conducted a site reconnaissance visit in October 2015 in preparation for a 2016 site investigation. Although the study plan is not yet available, it is anticipated that the project will involve at least two phases. The first phase will likely be a broad-scale screening of the entire stream reach within the defined project area with a higher density of sampling around suspected source and contamination areas. The purpose of this phase will be to better identify the actual area(s) of impact and the primary contaminants of concern (COC). Sediment, pore water (i.e., water between stream sediment) and/or column water from within the stream may be sampled and tested for parameters including metals (13 priority pollutants), PCBs, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and sediment grain size. Phase II will likely be a focused effort to target the most heavily impacted sites as well as sites with ongoing contamination. The purpose of this phase would be to identify whether contaminant discharge to the stream is currently ongoing, as well as to identify contaminant source(s) and probable points of entry. Furthermore, this phase will better characterize the areas of impact and determine which contaminants are having the greatest impact on the biological communities. Bioassay tests may be conducted to attempt to determine which COCs are most affecting the biological communities. Depending on study findings, an additional phase may be needed to help support remediation.

While the presence of legacy toxics in the watershed are widely recognized, recent surveys of brook trout in the stream have led to questions about the effect of legacy toxics on the ecological stability of the fish population and concerns regarding fish consumption. In August 2015, Maine DEP staff collected six brook trout and analyzed the tissue as two composites for metals and PCBs. This work was conducted through the Maine DEP's Surface Water Ambient Toxics (SWAT) Program and excerpts from the draft 2015 SWAT report are included below. Results from this survey are available in Appendix II, Table 2. Data on PCB levels were not yet available.

> *Results show that mean concentrations of metals in Goosefare Brook brook trout (GFS-BKT) were below No Observable Effects Concentrations (NOEC) for fish for all metals with such NOECs except for copper. Given that the concentrations of copper exceeded the NOEC for only one of the two composites and that there was a wide variation in concentrations between the two composites, these data should not be considered as definitive. In fact, since these NOECs were based on syntheses of limited studies, this assessment should be considered a screening level analysis. These fish tissue residue data do not address potential toxicity to other aquatic organisms from exposure to heavy metals in the sediments or water column, which can be better addressed by other methods.*
>
> *Mean concentrations in the trout were also below the Maine Center for Disease Control and Prevention (CDC)'s Fish Tissue Action Levels (FTALs) for human consumers, where there are any, for all but arsenic (As). Although total arsenic was measured, the toxic species is inorganic arsenic which is estimated as 10% of total and was only slightly above the FTAL. Concentrations of most metals were also lower than those in brook trout from two streams with no direct discharges or significant non-point sources, Cold Brook in Skowhegan and the Pleasant River in Deblois. Concentrations of chromium, copper, and zinc in Goosefare Brook trout were slightly higher than background concentrations, but well within an order of magnitude and not considered significant.*

3.2.5 PH

pH is a measure of the concentration of hydrogen ions in water on a logarithmic scale of 0 (acid) to 14 (basic). pH is determined by bedrock, acid rain deposition, wastewater discharge, and natural carbon dioxide fluctuations. pH regulates the solubility and biological availability of elements, including primary nutrients (phosphorus and nitrogen) and heavy metals. Low pH can release toxic metals and interfere with primary life functions. pH fluctuates naturally on a daily basis due to photosynthesis that consumes hydrogen ions for reaction processes. pH tends to be higher (more basic) during the day and be lower (more acidic) at night. These same daily patterns can be applied at the seasonal scale when photosynthesis becomes more prominent during the growing season. These fluctuations are typically very minor since there are buffering agents within the water (depending on contributing geology) that help protect against large swings in pH. Maine water quality standards allow a pH environment of 6.5 to 8.5 for all freshwater classes. Any values below or above this range can stress the physiological systems of most organisms and reduce reproduction success. Low pH can also allow toxic elements (ex. metals) to become mobile and/or "available" for uptake by aquatic organisms.

Although pH data is limited, measured values ranged from 6.65 to 7.36, within the standard range of 6.5 to 8.5 for freshwater streams in Maine. Concerns that the low pH flows from the Saco Heath could be a stressor for aquatic life in the headwaters of Goosefare Brook, especially when low pH water flushes out of the heath in early spring led the Maine DEP to conduct sampling in early spring 2015 at three stations: Bruno Circle (SGS45), Jenkins Road (SGS40) and Park and Ride (S-271). Bruno Circle readings were consistently very low (<4.5), however, pH values appear to recover before the Park and Ride station (Figure 7). Organisms at the Jenkins Road station could be impacted by low pH in early spring, but these values also appear to recover later in the season.

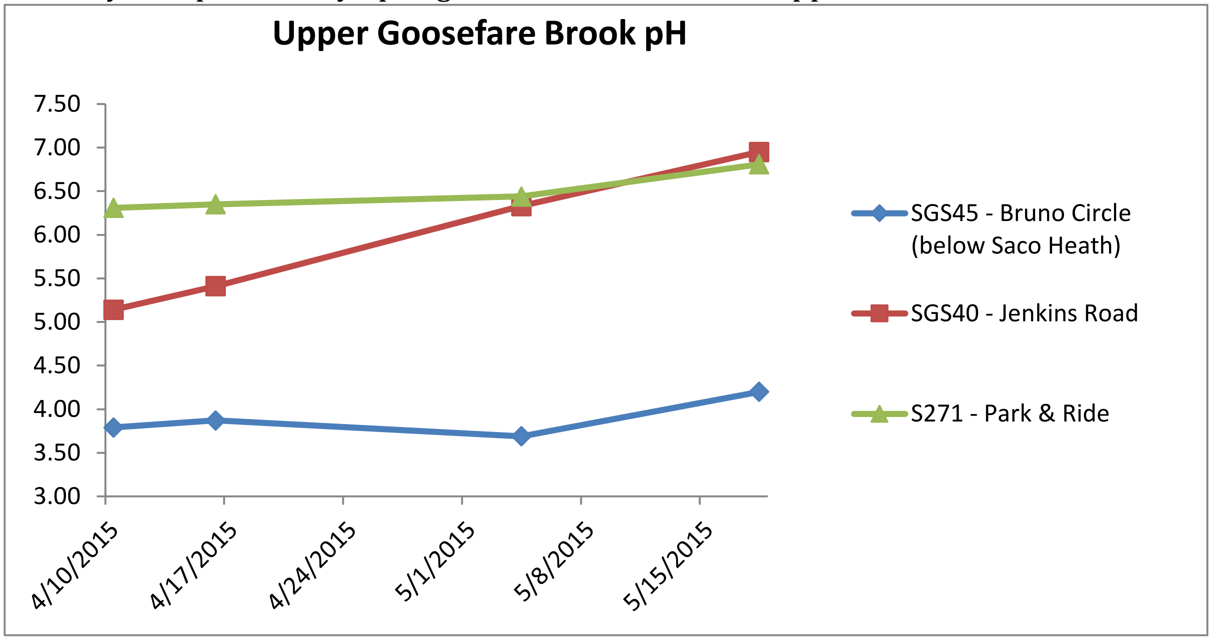


Figure 7. A summary of pH data available for Goosefare Brook from the Maine DEP.

However, low pH could explain the variation in biomonitoring surveys results at Jenkins Road.

3.2.6 PHOSPHORUS AND NITROGEN

Both phosphorus and nitrogen are essential nutrients to sustain growth. Total phosphorus (TP) includes all dissolved phosphorus (i.e. organic and inorganic phosphorus) as well as the phosphorus contained in or adhered to suspended particles, such as sediment and plankton (i.e. particulate phosphorus). Phosphate or orthophosphate (PO_4^{3-}) is the inorganic component of total phosphorus and is the most biologically available form of phosphorus. Total dissolved nitrogen (TN) is the sum of dissolved organic and inorganic nitrogen). Dissolved inorganic nitrogen includes ammonium (NH4+), nitrate (NO3-), and nitrite (NO2-). Ammonium is a waste product of metabolic processes in animals, and can be toxic in high amounts.

An example of algal growth in a Maine waterbody. PHOTO CREDIT: Maine DEP

Excess of both phosphorus and nitrogen can trigger problematic algal blooms and plant growth that can lead to cultural eutrophication. Eutrophication can cause deficiency of oxygen for aquatic organisms and cause other water quality problems. Higher concentrations of phosphorus are primarily associated with human activities within a watershed and are therefore important to monitor and control. Sources of phosphorus include: human waste, animal waste, industrial waste, soil erosion, fertilizers, disturbance of land and vegetation (e.g. draining or filling wetlands), agricultural runoff, and stormwater runoff. Synthetic phosphates are also often used in laundry detergents as a water softener. Phosphorus tends to "stick" to sediment, and in instances of shoreline disturbance or heavy rain events causing erosion, phosphorus attached to soil particles can be washed into waterways. Total phosphorus will also accumulate in slow moving stream reaches and in impoundments (i.e. upstream of a dam, and in lakes and wetlands) where particulate phosphorus settles out of the water column.

The EPA-recommended nutrient criterion for total phosphorus is 0.03 mg/L. Typical nitrate levels in undisturbed streams are usually 0 to 0.5 mg NO3-N/L; anywhere from 0.5 to 2 mg NO3-N/L suggests some level of disturbance; nitrate greater than 2 mg NO3-N/L clearly indicates disturbance. Ammonium is also usually low in undisturbed streams, typically less than 0.2 mg NH4-N/L. The EPA-recommended nutrient criterion for Ecoregion VIII for total nitrogen is 0.38 mg N/L.

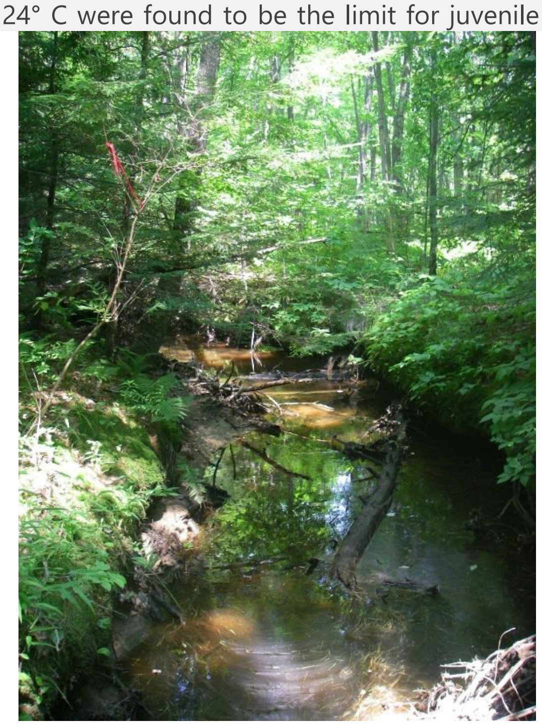
Only limited nutrient data is available in Goosefare Brook to supplement DO records. On August 8, 2015, Maine DEP collected baseflow measurements of PO_4^{3-}, TP, nitrate/nitrite and TN at four stations in the lower watershed with observed large diurnal swings. All four stations had elevated TP levels, but they did not exceed the EPA threshold. The Bear Brook (SGSBR01) and the tidal Goosefare Brook stations (SGS-06) approached this value (0.24 mg/L and 0.24, respectively) and all four sites had very low values of PO_4^{3-}. Low PO_4^{3-} values which indicate that the PO_4^{3-} had already been taken up by plants and algae in the stream. This corresponds to observations of abundant algae growth at the stations.

3.2.7 WATER TEMPERATURE

Stream water temperature plays an important role in regulating chemical reactions (e.g. dissolvability of elements) within the water and can be adversely impacted by urban development. Impervious surfaces heat up quickly when exposed to direct sunlight. Stormwater runoff over these hot impervious surfaces delivers unnaturally warm water to streams, also known as thermal pollution. High volumes of warm water from overland flow or groundwater mixes with cooler stream water, leading to increases in stream water temperature (UNHSC, 2011). Stream temperature is also regulated by the amount of shading by riparian vegetation along immediate stream banks. More open canopies allow sunlight to reach surface waters, which can heat up quickly during the day. Many fish species thrive under optimal water temperatures, which trigger reproductive functions and regulate growth of juvenile fish. Maximum weekly and instantaneous temperature means of 19° and 24° C were found to be the limit for juvenile brook trout survival (Brungs and Jones 1977).

Unlike other water quality parameters, temperature does not appear to be a major concern for Goosefare Brook and its tributaries. Temperatures for all but one monitoring station were relatively cold, even during the summer months. The highest summer baseflow temperatures for most stream monitoring stations ranged from 17-18.5° C, and three stations had very cold temperatures, typically below 16° C. Trout Brook (SGSBP01), in particular, had the coldest temperatures with 2014 average temperature of 11.2° C and a maximum temperature of 15.2° C (Figure 8).

Two stations had temperatures slightly higher than other observations in the watershed. Bear Brook (multiple stations) and Goosefare Brook at Ross Road (SGS15) frequently had daily high temperatures over 20° C, and the highs sometimes exceeded 21 and 22° C. The Ross Road station is located below a large open wetland complex, which allows sunlight to reach and warm the stream.



Shaded stream channels help reduce temperatures in freshwater streams.
PHOTO CREDIT: Maine DEP

Stream temperatures appear to recover downstream of Ross Road and at Ocean Park Road (SGS04). The stream is several degrees colder, likely due to shading through a long wooded section as well as the cold water inputs from Trout Brook. As discussed in section 3.3.1, the SCA survey found numerous sections along Bear Brook with inadequate buffers and lack of stream shading which could be contributing to warmer water temperatures.

The only monitoring station with very high temperatures was Industrial Park Road South Tributary (SGSIPS), which is more of a network of unshaded ditches and storm water conveyances than a natural buffered stream. In 2015, water temperatures climbed over 30° C, which would be a major stressor if there were sensitive aquatic life in the stream. Although it has a relatively small flow volume, it likely does increase the temperature where it joins with Goosefare Brook.

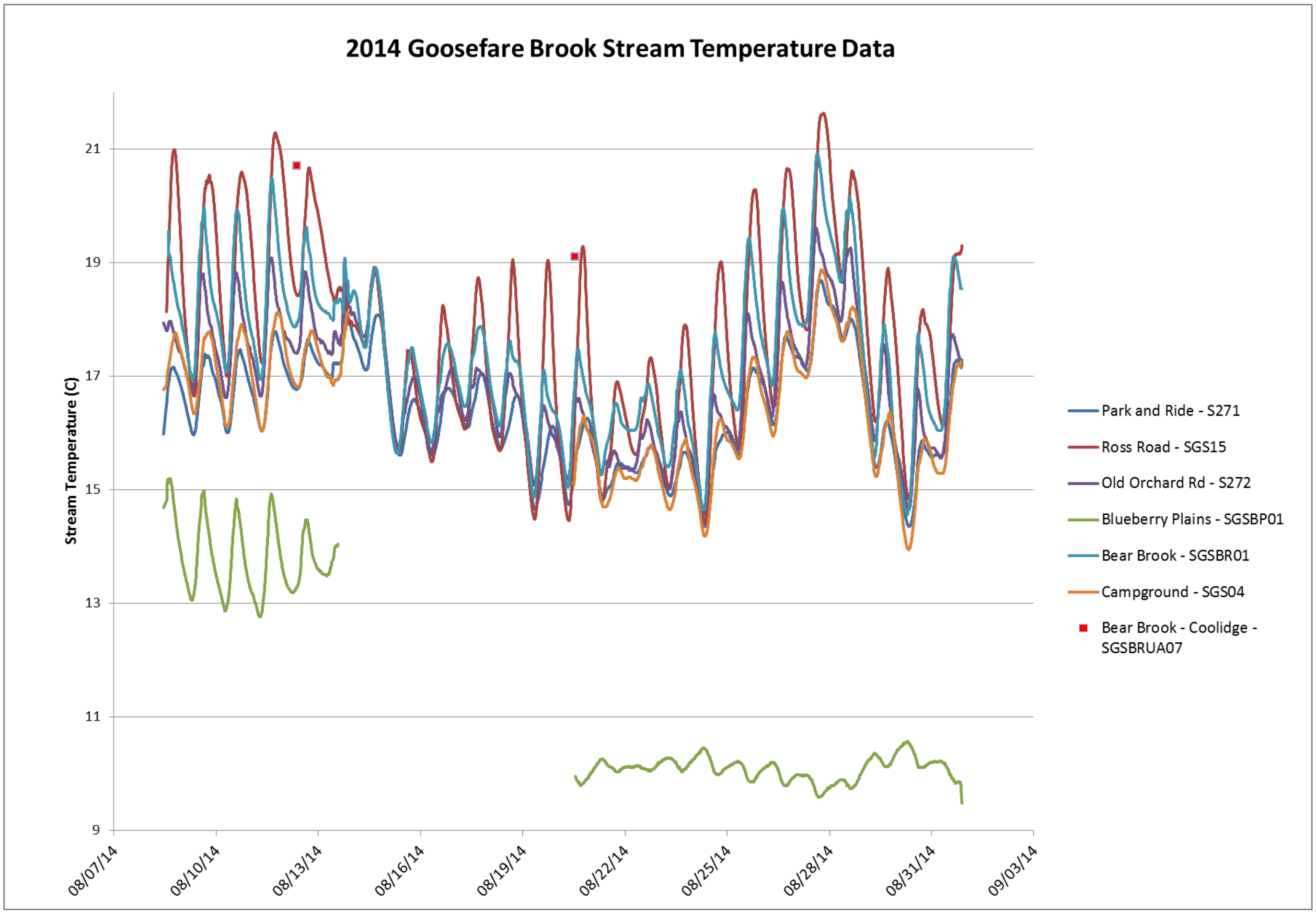


Figure 8. Continuous temperature data monitored in 2014 by the Maine DEP.

3.2.8 BACTERIA

Surface waters near developed areas are impacted by fecal contamination from polluted stormwater runoff, malfunctioning septic systems, pet, livestock, and wildlife waste, leaky sewer lines, and other aging infrastructure on residential, municipal, and commercial properties. This fecal contamination generates a significant threat to water quality, public health, and the local economy.

Monitoring, tracking, and managing pathogens in fecal matter is extremely difficult, particularly when fecal indicators (e.g., *E.coli,* Enterococci, or fecal coliform) are also highly variable to track and measure. Fecal indicator bacteria are used to detect fecal contamination and the pathogens associated with fecal matter in surface waters. Previous studies of beaches impacted by point sources of sewage discharge found a significant correlation between FIB and the probability of gastrointestinal illness in swimmers. The USEPA recommends single sample maximum values for Enterococci in marine waters at 104 MPN/100 ml and has a recommended geometric mean of 35 MPN/100 ml.

Since 2009, MHB staff and volunteers have monitored *Enterococcus* bacteria levels in Goosefare Brook and its tributaries and documented numerous exceedances in recreational water contact safety standards, which has triggered numerous swimming advisories. Early monitoring efforts with the MHB focused primarily on the mouth of Goosefare Brook, but since 2010 monitoring efforts expanded upstream to help identify pollution sources.

In 2011 and 2012, DEP partnered with MHB as part of the Maine Statewide Bacteria TMDL: Freshwater Addendum (Maine DEP 2014). The USEPA also assisted with the study by analyzing samples for pharmaceuticals and nutrients. As a part of this effort, 177 samples were analyzed for *Enterococci* at 37 sites; 102 samples were analyzed for *E. coli* at 17 sites; 145 optical brightener samples were analyzed at 25 sites; 24 samples were analyzed for various pharmaceuticals at 13 sites; and 23 samples were analyzed for nutrients at 21 sites. In 2012, Ocean Park Conservation Society contracted with Canine Detection services to "sniff out" human sources.

Results from these studies indicated widespread bacterial contamination throughout Goosefare Brook. Bear Brook and the New Salt Road Tributary tend to be the areas with highest bacteria levels that far exceed standards. Only two stations had *E. coli* levels below state standards. The USEPA's data showed elevated levels of several pharmaceutical compounds (acetaminophen, caffeine, carbamazepine, cotinine and 1,7-dimethlyxanthine) in baseflow conditions in both Goosefare Brook and Bear Brook. Additionally, one of the two dogs used in the canine detection work indicated the presence of human-sourced bacteria at the mouth of the Route 1 North tributary. Although animal sources may also be a contributing factor, human wastewater associated with sewer and septic systems are likely significant problems.

> *"Pollutants from upland areas are transported to the shoreline via freshwater inputs such as rivers, streams, and storm drains, especially during and following rainfall. As part of ongoing efforts to restore the Goosefare Brook, the City of Saco and Town of Old Orchard Beach have successfully identified and remediated numerous contamination sources and have invested in wastewater and stormwater infrastructure improvements to restore the ecosystem integrity. It is recommended that these communities continue these infrastructure upgrades as well as the identification and removal of sources, particularly human sources. These efforts to clean up the Brook translate to improved beach health, reduce beach advisories, and help ensure a safer beach experience for the community and visitors to the area. Efforts to keep beaches healthy are important for economic health as beaches are a valued resource for Maine's coastal communities." – Meagan Sims, Maine Healthy Beaches*

Since 2012, DEP has focused primarily on *E. coli* in freshwater areas, and MHB and Old Orchard Beach have focused on *Enterococci* in the brackish areas. MHB efforts have centered on New Salt Road Tributary as the most important 'hotspot' (Appendix II, Tables 4 – 6). In 2014, MHB collected 180 *Enterococci* samples at 17 sites and 149 optical brightener samples at 16 sites throughout the New Salt Road Tributary watershed. *Enterococci* values ranged from <10 to 6,490 MPN/100 ml with a combined geometric mean of 275 MPN/100 ml for all sites (MHB 2015). The highest areas along the New Salt Road Tributary are consistently located by monitoring stations GFB-01 (Temple to Ancona) and GFB-05 (by the marsh at Oceana). Sampling in 2015 extended longer than previous years, with sampling beginning in early May and going throughout October. In general, bacteria levels in 2015 had little change from 2014, however, the longer sampling season includes sampling dates during the spring and fall seasons when there are less residents and therefore lower septic loads. For these reasons, geometric and arithmetic means appear lower when in reality, bacteria levels remained fairly constant. In 2015, bacteria sampling was completed at 19 sites with 171 paired optical brightener and *Enterococci* samples with an average optical brightener of 78.77 µg/L (all 2015 samples; end of May through end of September average 79.15 µg/L). The geometric mean for all samples is 156.37 MPN/100ml with a geometric mean of 205.0 MPN/100ml in the shorter season (end of May through end of September), significantly higher than the average for the entire sample set. Including the 2015 samples, monitoring efforts since 2012 include 526 *Enterococci* samples and 533 optical brightener samples. The average optical brightener across all samples since 2012 is 87.18 µg/L and the geometric mean for *Enterococci* across all samples is 183.11 MPN/100ml.

Recent Efforts to Detect and Address Potential Bacteria Sources

2014

OOB conducted dye testing on 68 homes with no malfunctions detected; replaced over 2,500 ft. of sewer lines; and repaired 2 sets of leaching pipes at dead end roads along the beach.

Saco televised and cleaned sewer lines; completed a comprehensive flow analysis within Bear Brook watershed sanitary sewer system, replaced manholes and sewer laterals, and separated a drain line from the sanitary system.

2015

City of Saco completed a pipe bursting project to replace clay pipe with PVC along 2000 feet of Bear Brook. Fixed broken sewer lateral pipe that was discharging to the stream. Problem was identified as part of the SCA Survey.

OOB performed a sewer smoke test to track potential sources of contamination into Goosefare Brook.

Since the inception of bacteria monitoring, data have been shared with Saco and Old Orchard Beach over the course of these bacteria studies. Both municipalities have conducted property surveys to identify malfunctioning septic systems as well as investigations of sewer and stormwater infrastructure. This has led to removal of numerous grey and black water discharges throughout the watershed as well as upgrades and expansion of sewer and stormwater infrastructure. Despite these efforts, bacteria levels continue to be elevated in both fresh and brackish areas.

3.2.9 FISHERIES

Before the turn of the last century, Goosefare Brook and Deep Brook were considered favorite fishing areas in the Saco area. In the 1870s, local sportsmen held an annual fish and game hunt that focused on harvesting salmon and trout for an annual gala (Goosefare Brook Watershed Survey Report 2002). Although the stream was later considered 'fished out', Goosefare Brook and its tributaries are considered brook trout habitat. Recent surveys and local anecdotal evidence indicates that the stream once again has a healthy fishery in places.

The Maine IF&W conducted a survey on 7/18/58 at an unknown survey site in Old Orchard Beach and noted heavy fishing pressure. The survey identified two legal brook trout and abundant black-nosed dace, brown bullhead, golden shiners, eels, white suckers and three spine stickleback.

Maine IF&W conducted surveys in 1983 and 1986 as well and documented numerous American eel and lake chub at three locations, but very limited brook trout presence (Appendix II, Table 6). As part of the watershed survey planning process, Maine IF&W conducted an electrofishing survey at five sites on July 23, 2015. They found brook trout at all five sites. They noted especially good habitat and healthy populations at two upstream sites, despite observed adjacent development impacts at the Park and Ride site.

Maine IF&W biologist displays a brook trout collected on Goosefare Brook adjacent to the Park and Ride on Industrial Park Road on 7/23/15. PHOTO CREDIT: Maine IF&W

In addition to brook trout, another species of interest for Goosefare Brook is smelt. In 2004, the National Oceanic and Atmospheric Administration listed the rainbow smelt as a federal Species of Concern. The rainbow smelt is a small fish that lives in estuaries and offshore waters, and spawns in shallow freshwater streams each spring. Its numbers have dropped dramatically during the last fifteen to twenty years for reasons that are not well understood. Although smelt has not been identified in Goosefare Brook surveys, the tidal portion of the stream is identified as potential smelt habitat (see Maine Stream Habitat Viewer).

3.3 GEOMORPHIC AND IN-STREAM HABITAT ASSESSMENTS

3.3.1 STREAM CORRIDOR ASSESSMENT

In July and August 2015, project staff conducted an SCA survey for Goosefare Brook and its tributaries. The SCA survey method (Maryland DNR 2001) rapidly assesses the general physical condition of the stream and identifies the location of a variety of environmental problems and restoration opportunities within the stream corridor. The primary types of problems sites documented in Goosefare Brook included erosion sites, inadequate stream buffers, yard waste dumping sites, and stream channel alterations. Survey teams collected information about the size, location, and severity of each site and also rated the feasibility of restoration. Site ratings were based on the following:

- **Severity** is ranked five (most severe) through one (minor problems). A ranking of five indicates that the problem is among the worst that the field team has seen or would expect to see. This might include a severely eroding streambank that extends 500 feet.
- **Correctability** is ranked five (easily remediated) through one (major endeavor). A ranking of one would require a large expensive effort to correct using heavy equipment, a large amount of funding, and more than a month of construction time. Example: fish barrier caused by a permanent dam.
- **Accessibility** is the relative measure of how difficult it is to reach an identified site and is ranked five (easily accessible by car or foot) through one (difficult to access both by foot and vehicle). Examples of a site that could be ranked as very difficult include access over steep or heavily wooded terrain with no trails or roads nearby.

Following the field survey, site information was uploaded to GIS maps and Excel spreadsheets and locations were checked for accuracy. An additional rating was made for each site to identify and give high scoring to sites with higher stream restoration benefits. Sites with problems related to the primary stressor and impairment for a stream segment were assigned three additional points. Sites with multiple problems (e.g., erosion and inadequate buffer, etc.) where restoration would provide multiple benefits were also assigned additional points. If there were more than two problems, the site would receive two points. Cost was also approximated for each site. Stream Corridor Survey locations and findings are summarized in appendix tables (Appendix III, Tables 8 - 12) and described in detail in the following sections.

EROSION SITES

Streams naturally transport a certain amount of sediment through their systems, but excess sediment can be harmful to both stream habitat and water quality. Excess sediment can fill in the spaces between gravel and other rocks in stream bottoms, eliminating spawning areas, suffocating eggs, and eliminating habitat for aquatic insects (Maine DEP Stream Survey Manual 2010). Nutrients and other pollutants attached to soil particles can impair water quality.

The SCA survey documented 44 soil erosion problems in and adjacent to the stream (Appendix I, Map J; Appendix III, Table 7). Some sites were limited in size (20 feet long), and others extended several hundred in length. The total length of eroded sites was over 4,800 feet. Many of the erosion sites were associated with areas of inadequate buffers with lawn growing along the streambanks. Other erosion sites were associated with stormwater outfall pipes, road crossings, or footpaths. Several sites were located in the tidal portion of Goosefare Brook and appear to be due to natural processes. In terms of severity, 18 sites were rated as high or very high, 23 were moderate, and three were rated minor.

INADEQUATE BUFFERS

Trees and shrubs alongside streams, known as **buffers** or **riparian areas**, provide many stream benefits. These plants provide shade to keep water temperatures cool and filter out pollutants carried by stormwater. The deep roots of trees and shrubs help stabilize streambanks and reduce erosion. In terms of stream habitat, the leaves and twigs from buffer plants provide food for aquatic life in the stream. Large wood that falls into the stream channel also captures this

> **BUFFERS AND RIPARIAN AREAS** or *"buffer" refers to the riparian, or near-shore, area of the stream. These areas are crucial for controlling erosion and sediment delivery to the water. Vegetated riparian areas provide shade and keep water temperatures cool as well as filtering out nutrients from stormwater runoff.*

food, provides cover for fish, and helps create pools and other diverse habitats of aquatic life.

The SCA survey documented 33 sites where the stream buffer was absent or inadequate (Appendix I, Map K; Appendix III, Table 8). The estimated length of inadequate buffer was just over 10,000 feet (6,000 feet on the left bank and 4,500 feet on the right bank). In terms of relative severity, there were five high, 26 moderate, and three minor sites. Nine of the sites were located adjacent to places where excessive algae were observed in the stream. Removal of the riparian vegetation allowed sunlight to reach the stream in these areas and allows algae to thrive. Average estimated buffer width was 19 feet. However, there were 24 sites with buffer widths less than or equal to 10 feet.

YARD WASTE DUMPING SITES

Grass clippings found during the 2015 Stream Corridor Assessment. PHOTO CREDIT: MAINE DEP

Although yard waste piles located outside the buffer area are usually benign, dumping on streambanks can impact stream health. Grass clippings can carry excess nutrients and pesticides into the stream. Piles of yard waste can also smother natural vegetation and leave the stream vulnerable to bank erosion.

Dumping was documented at 12 sites adjacent to the stream (Appendix I, Map L; Appendix III, Table 9). Eight of the sites were piles of grass clippings and brush immediately next to or in close proximity to the stream. Four sites were associated with historic trash dump sites (e.g., tires, vehicle, and other debris). In terms of severity of the sites, there were five severe, four moderate, three minor, and one very minor site.

The two documented tire dump sites were addressed following the survey. An AmeriCorps member working with DEP on the SCA survey approached the Old Orchard Beach Campground owner about hosting a cleanup event, and the landowner was eager to deal with this long-standing eyesore. On October 2, 2015, a dozen volunteers and campground staff removed 60 tires from the stream. There was also discussion and preliminary planning about removing a vehicle from the stream in the near future. It would be relatively easy to address all of the yard waste debris as well; however, landowner education and alternatives would need to be provided to help change the long-term behavior.

STREAM CHANNEL ALTERATION

An altered stream channel found during the 2015 Stream Corridor Assessment. PHOTO CREDIT: Maine DEP

Stream channel alterations include any human-made changes to the stream course or channel shape (such as straightening or widening the stream). Alterations can also include additions of dams, retaining walls, or other channel armoring. Such structures and alterations can block fish passage, impair stream habitat, slow down stream flow, and create channel instability. Eleven channel alteration sites were identified in the SCA survey and another three problem sites were identified by the geomorphic assessment (Appendix I, Map M; Appendix III, Table 10). The geomorphic sites are discussed in a subsequent section. The remaining eleven sites included six sites where the stream had been straightened and armored with riprap; two sites with riprap on the stream bottom creating an impoundment; two historic structures adjacent to the stream; and one collapsed concrete culvert. The straightened and riprapped stream segments create geomorphic and habitat issues; however, restoration could be challenging due to the proximity of roads and other infrastructure.

STREAM HABITAT SURVEY

To support fish and other aquatic life, stream habitat should include elements such as a wide variety of pools, fast flowing riffles, large pieces of wood, overhead tree canopy, and a stable stream bottom (Maine DEP 2011b). These features create diverse conditions required by different aquatic organisms for survival and reproduction. Pools and large wood in streams trap food and provide cover and refuge for creatures. Stable streambeds covered with gravel provide spawning areas for fish and homes to diverse macroinvertebrates. Tree canopy shades the stream and fallen leaves provide food for aquatic organisms. As watersheds become more urbanized, stream habitat is often degraded and destabilized.

The SCA survey included a rapid habitat assessment at 32 sites in the Goosefare Brook watershed. The survey evaluated ten habitat parameters important for aquatic life with scoring categories *Poor*, *Marginal*, *Suboptimal,* and *Optimal* (Appendix I, Map N; Appendix III, Table 11). In the overall ratings, five streams were rated optimal, 24 were rated suboptimal, and three were rated marginal (Figure 9).

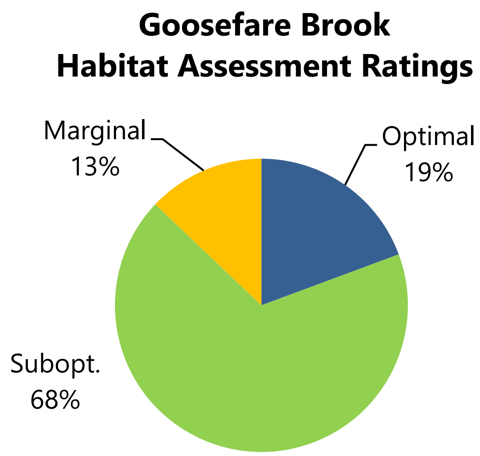


Figure 9. Habitat Assessment Ratings from the Stream Corridor Assessment.

In general, most sites rated well in the following categories: riparian habitat, bank condition, bank vegetation, and channel alteration (Figure 10). Since many stream segments were low gradient with sand/silt substrate, many of the sites rated poorly in terms of macroinvertebrate substrate, embeddedness, and velocity depth categories. Segments with gravel or cobble bottoms rated higher in these categories. The suboptimal and marginal streams tended to have very little wood present and poor flow and habitat diversity, which can limit macroinvertebrate habitat. Habitat can be improved by additions of wood either naturally or artificially.

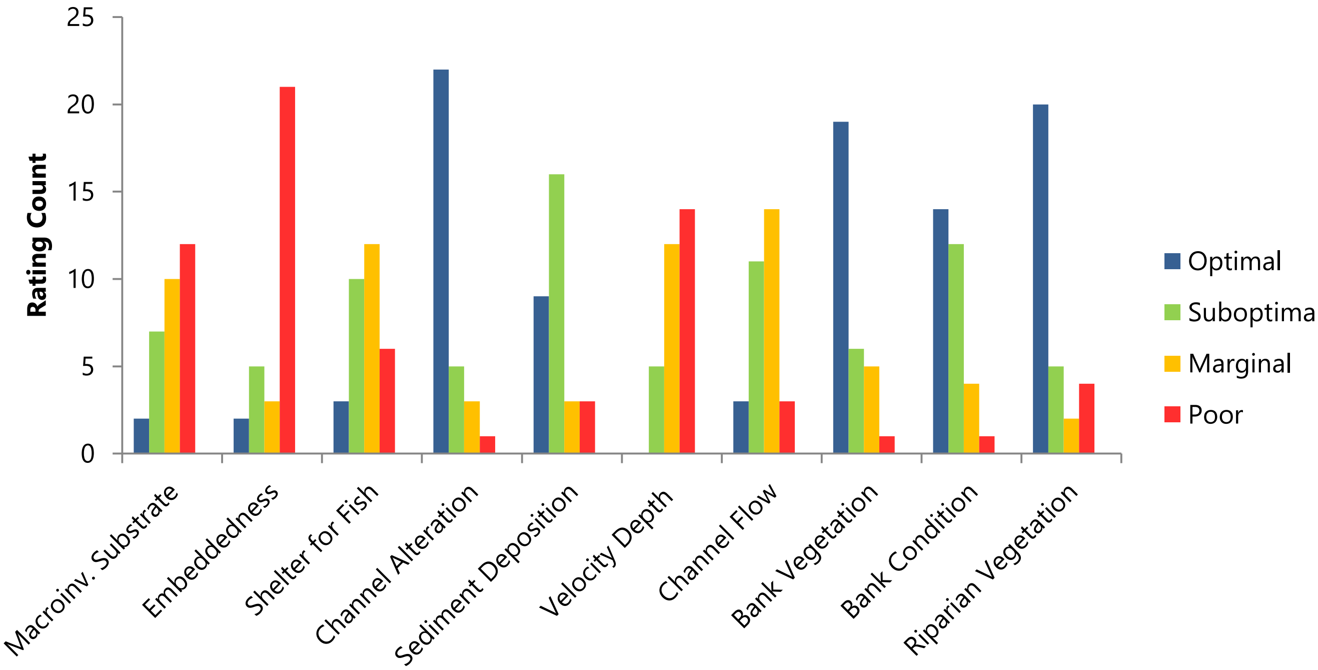


Figure 10. Summary results from the 2015 Rapid Habitat Assessment ranging from optimal → poor habitat.

3.3.2 GEOMORPHIC RECONNAISSANCE

Fluvial geomorphology is the study of the shape and stability of stream systems. Although all streams change over time, human disturbance can destabilize the natural equilibrium in stream systems. In urban streams, increased impervious surfaces and runoff can result in higher stream and bank erosion, which can directly affect stream habitat conditions. In addition, physical alterations to stream channels (e.g., straightening and widening) can spread out and slow down stream flow, which can also impact stream habitat, temperature, and dissolved oxygen levels.

Examples of findings from the RGA, bank armoring at Upper Bear Brook. PHOTO CREDIT: John Field (see Field 2015)

During the 2014 and 2015 field work, project staff did not observe widespread geomorphic issues in the Goosefare Brook watershed. However, several areas were identified for further geomorphic assessment. A reconnaissance-level fluvial geomorphic assessment was completed by John Field of Field Geological Services in August 2015 to determine the impact of urbanization on channel morphology and identify methods for restoring aquatic habitat and channel stability. Six sites were visited on the main stem as well as Bear Brook and the Moody Street Tributary.

A rapid geomorphic assessment (RGA) form developed by Maine IF&W was completed at each site, where appropriate, to identify active channel processes and instabilities. The RGA uses visible physical characteristics of the stream to identify whether the stream is undergoing morphological adjustments associated with aggradation (e.g., presence of bars, siltation in pools), degradation (e.g., headcuts, elevated tree roots), widening (e.g., leaning trees, erosion on both sides of channel), or planform changes (e.g., cut-off channels, formation of islands). Depending on the total number of features observed that are indicative of these adjustments, the stream is characterized as either "in adjustment" (i.e., numerous observed features), "transitional or stressed" (i.e., some observed features), or "in regime" (i.e., very few or no observed features) (Table 5; Appendix I, Map O). The results of the RGA were supplemented with additional observations to further characterize conditions at the site and better understand the potential causes and remedies for channel instability. Findings were summarized in a comprehensive report by Field Geological Services (see Field 2015).

Table 5. Results from the 2015 Geomorphic Survey. Sites are ordered from upstream→downstream for Goosefare Brook, followed by Bear Brook, and then the Moody Street Tributary.

LOCATION	RGA RATING	OBSERVATIONS	RESTORATION PRIORITY
Goosefare Brook - Park and Ride	Transitional	Wide forested floodplain, sinuous channel, little sediment deposition in channel. Stream naturally recovering from historic clearing. Abundant wood recruitment into stream.	Low
Goosefare Brook – Route 1	NA	Wetland system with wide, low floodplain. Stream not impounded (obstructed) by culvert. Floodplain relief culverts could be installed to address flood flows and large scour pool below culvert.	Low
Goosefare Brook – Ross Road	In Regime	Wide forested floodplain, lack of channel deposition, sinuous channel. However, lack of wood in stream	Medium

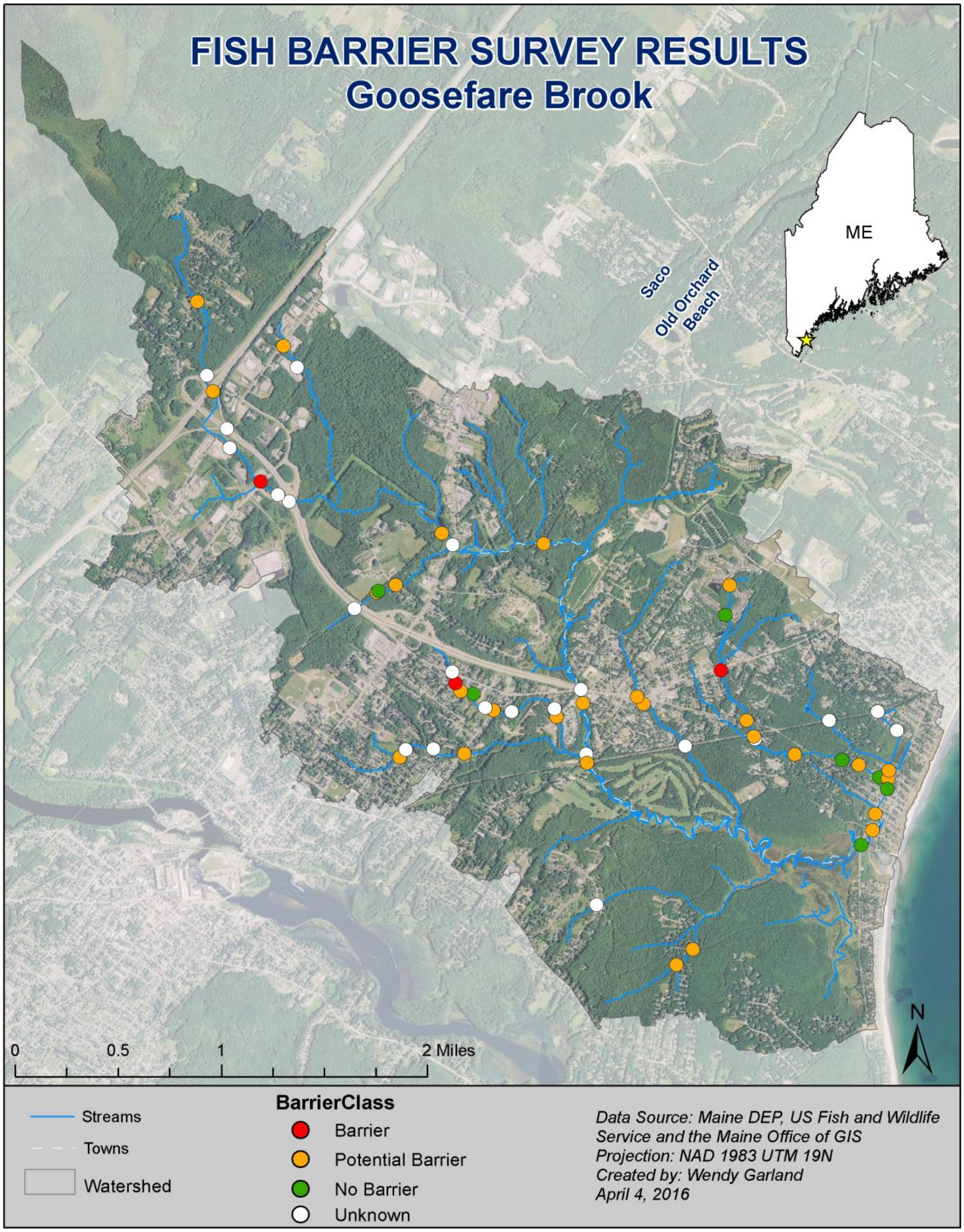
		reduces aquatic habitat. Undersized culvert creates scour pool. Could add anchored wood to stream to speed recovery; enlarge culverts; and install floodplain relief culverts.	
Upper Bear Brook	Transitional	Artificially constructed and widened channel; eroding and armored banks; development infringes on floodplain. Lack of wood limits aquatic habitat. Install wood in low densities; remove channel armoring; stabilize eroding areas with log cribbing.	High
Lower Bear Brook	Transitional	High banks and undersized culvert causes severe downstream bank erosion and stream deposition. Otherwise, stable banks and abundant wood and natural floodplain. Recommend enlarging culvert; using existing culvert as floodplain relief culvert; and using trees on sloughing banks to stabilize bank.	Medium
Upper Moody Street Tributary	NA	Artificially straightened and widened channel adjacent to pipeline. No wood additions recommended due to small, headwater area and threat to infrastructure.	Very Low

3.3.3 FISH BARRIER STUDY

The Nature Conservancy, with support from the U.S. Fish and Wildlife Service, conducted a fish barrier survey of the Goosefare Brook watershed in 2015 using the NAACC Stream Crossing Survey Data Form Instruction Guide (2015) to survey stream crossings, and the Maine Dam and Natural Barrier Survey Manual (2008) to survey dams and natural obstructions. Surveyors assessed 40 stream crossings and measured culvert size, outlet drop, pool depth, and numerous other parameters. Staff evaluated the data and rated fish culverts as passable, barriers, or potential barriers for aquatic organisms. Preliminary data indicates that seven crossings were rated as passable, 27 were rated as potential barriers and three were rated as barriers (Table 6; Appendix I, Map P). Problems associated with the barriers included hanging, undersized, and multiple culverts. Survey data will be finalized in 2016 and placed on the Maine Stream Habitat Viewer at http://mapserver.maine.gov/streamviewer/index, which will help prioritize the potential barriers.

Table 6. Data from the 2015 Fish Barrier Assessment.

SITE ID	BASIC STRUCTURE	BARRIER CLASS	STREAM	ROAD NAME	TOWN
55061	Culvert	Barrier	Tributary	Route 5	OOB
55276	Multiple Culvert	Barrier	Goosefare Brook	Industrial Park Road	Saco
55413	Culvert	Barrier	Tributary	Ocean Park Road	Saco
55059	Culvert	No Barrier	Tributary	Free Street	OOB
55063	Bridge	No Barrier	Tributary	Clover Street	OOB
55649	Bridge	No Barrier	Goosefare Brook	Seaside Avenue	OOB
55882	Culvert	No Barrier	Tributary	Multiple	OOB
60178	Culvert	No Barrier	Tributary	Kavanaugh Road	OOB
55410	No Crossing	No Barrier	Tributary	Truman Avenue	Saco
56164	Culvert	No Barrier	Tributary	Eastern Trail	Saco
55058	Culvert	Potential Barrier	Tributary	Macintosh Lane	OOB
55060	Culvert	Potential Barrier	Tributary	Manor Street	OOB
55064	Multiple Culvert	Potential Barrier	Tributary	Temple Avenue	OOB
55183	Multiple Culvert	Potential Barrier	Goosefare Brook	Ross Road	OOB
55199	Multiple Culvert	Potential Barrier	Tributary	New Salt Road	OOB
55485	Culvert	Potential Barrier	Tributary	Old Orchard Road	OOB
55486	Multiple Culvert	Potential Barrier	Tributary	Route 5	OOB
55491	Multiple Culvert	Potential Barrier	Tributary	West Grand Avenue	OOB
55560	Bridge	Potential Barrier	Tributary	Winona Avenue	OOB
55561	Culvert	Potential Barrier	Tributary	Oceana Avenue	OOB
56167	Bridge	Potential Barrier	Goosefare Brook	Train Tracks	OOB
60177	Culvert	Potential Barrier	Tributary	Unknown	OOB
60179	Culvert	Potential Barrier	Tributary	Unknown	OOB
55261	Multiple Culvert	Potential Barrier	Goosefare Brook	Unknown	Saco
55271	Multiple Culvert	Potential Barrier	Tributary	Jenkins Road	Saco
55275	Culvert	Potential Barrier	Goosefare Brook	I-95	Saco
55390	Culvert	Potential Barrier	Goosefare Brook	Eastern Trail	Saco
55406	Culvert	Potential Barrier	Bear Brook	Unknown	Saco
55409	Culvert	Potential Barrier	Tributary	Cumberland Avenue	Saco
55411	Culvert	Potential Barrier	Tributary	Coolidge Avenue	Saco
55512	Culvert	Potential Barrier	Tributary	Atlantic Way	Saco
55544	Culvert	Potential Barrier	Tributary	Industrial Road Park	Saco
55645	Culvert	Potential Barrier	Tributary	Moody Street	Saco
55733	Culvert	Potential Barrier	Tributary	Cumberland Avenue	Saco
55934	Multiple Culvert	Potential Barrier	Tributary	Locke Street	Saco
56163	Culvert	Potential Barrier	Tributary	Eastern Trail	Saco
60483	Culvert	Potential Barrier	Tributary	Midwood Drive	Saco
55262	Culvert	Unknown	Goosefare Brook	Route 5	Saco
55559	Culvert	Unknown	Goosefare Brook	Old Orchard Road	Saco
55646	Culvert	Unknown	Tributary	Route 195	Saco



Results from the USFWS Fish Barrier Study. Refer to Appendix I, Map P.

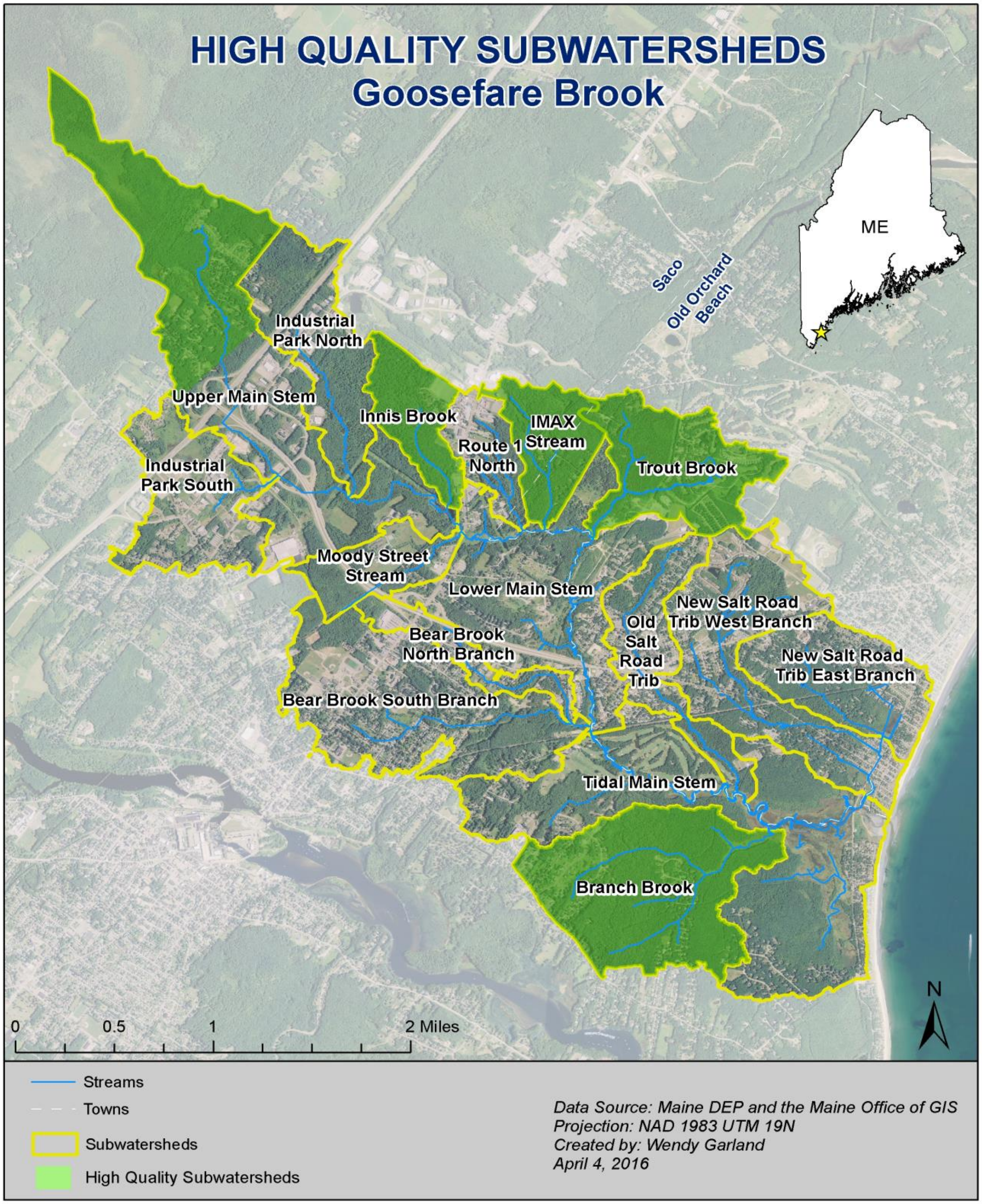
4 STRESSOR IDENTIFICATION

The Stream Monitoring and Assessment Committee (SMAC) evaluated available water quality and survey data for each of the 16 subwatersheds. For each associated stream reach, they evaluated stream health, the degree of existing and potential impairments and identified stressor associated with these threats or impairments. Five stressors (nutrients, toxics, chloride, bacteria, and stream habitat) were identified as contributors to existing and potential future impairments in Goosefare Brook. The definition of these stressors and their corresponding impaired and impacted subwatersheds are summarized below in sections 4.2.1 through 4.2.5. The identification of stressors for various subwatersheds also helps hone in on pollution source areas and target restoration and protection strategies.

4.1 HIGH QUALITY SUBWATERSHEDS

Five of the sixteen subwatersheds have been identified as "high quality", indicating that the physical and chemical monitoring of the surface water, whether it be Goosefare Brook or a tributary, has good water quality. These five subwatersheds are as follows; Upper Main Stem, Innis Brook, IMAX Stream, Trout Brook, and Branch Brook (Appendix I, Map Q). Because these subwatersheds have good water quality, they were not targeted for structural and non-structural recommendations. However, it is important to maintain this high water quality through proper infrastructure maintenance, future land use planning, and monitoring. Two of these high quality watersheds contain significant amounts of conserved land. The Saco Heath is located in the Upper Main Stem and a portion of the Rachel Carson Wildlife Refuge is located in Branch Brook. Due to conservation efforts, these land parcels have low IC and reduced stormwater runoff inputs to the stream. This plan recommends further stream protection ordinances and acquisition of land for conservation in the remaining three subwatersheds (Innis Brook, IMAX Stream, and Trout Brook), currently holding little conserved land, to protect the high quality waters in these areas.

Sunset over the Goosefare Brook estuary. PHOTO CREDIT: FBE

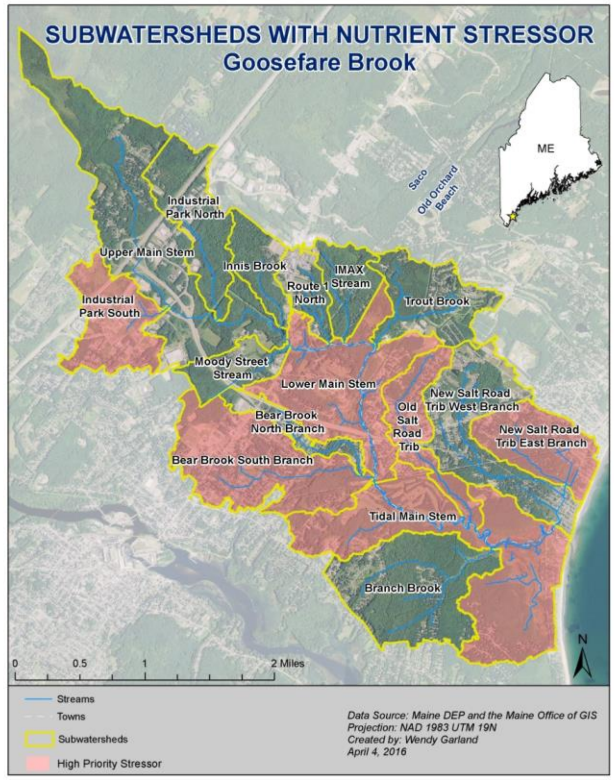


High quality subwatersheds in the Goosefare Brook watershed. Also refer to Appendix I, Map Q.

4.2 IMPAIRED/IMPACTED SUBWATERSHED STRESSORS AND SOURCE AREAS

4.2.1 NUTRIENTS

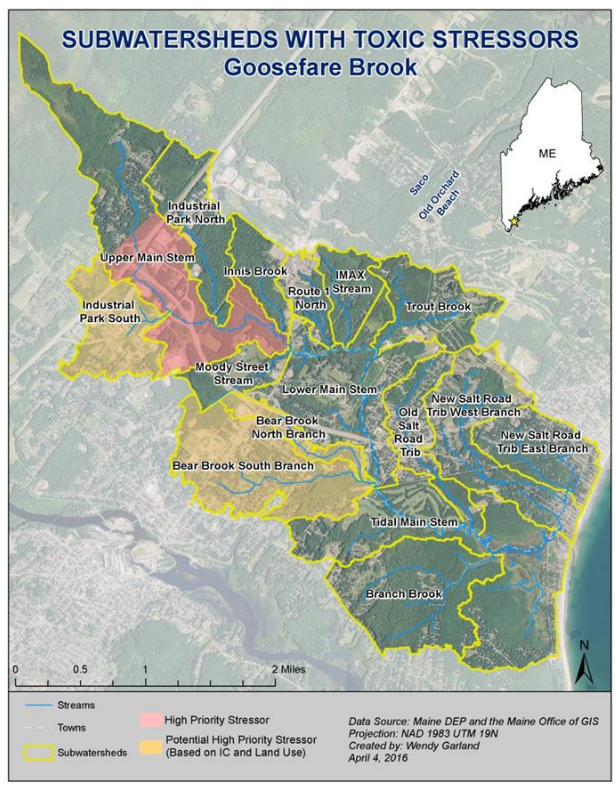
Six subwatersheds within the Goosefare Brook Watershed are impacted by excess nutrients in the surface water. This was determined by a combination of observations of excessive algal growth, large diurnal DO swings and direct nutrient measurements. Excess nutrients (primarily nitrogen and phosphorus) originate from sources within the watershed such as fertilizer application, soil erosion, and biological waste. The six subwatersheds in Goosefare Brook that are currently impacted for nutrients are; Industrial Park South, Lower Main Stem, Bear Brook South Branch, Old Salt Road Tributary, New Salt Road East Branch, and the Tidal Main Stem. (see Appendix III, Map R).



Refer to Appendix I, Map R.

4.2.2 TOXICS

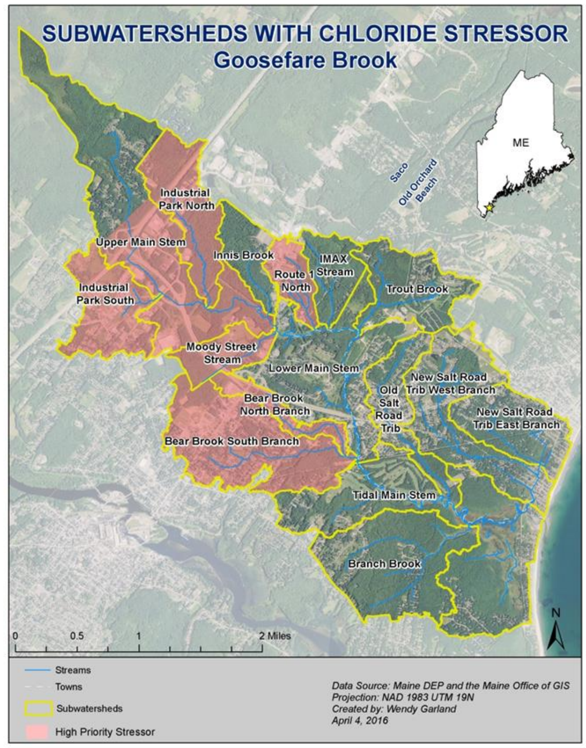
Elevated levels of heavy metals in Goosefare Brook caused it to be listed as impaired for toxics in the Maine DEP 2003 TMDL. Toxins occur at natural levels in water bodies; however, when they are too concentrated they can negatively impact the behavior, reproduction, and overall survival of aquatic organisms. The Maine SWQC and the USEPA set concentrations standards to protect aquatic ecosystems. Toxics were identified as a priority stressor in four subwatersheds. The Upper Main Stem of Goosefare Brook was the highest priority subwatershed with associated toxics impacts due to the very low number of aquatic macroinvertebrates and proximity to the Saco Steel facility. An upcoming study by USEPA will investigate the nature and extent of toxic impacts in this area and identify remediation strategies, if needed. Toxics were identified as a high priority stressor in three other subwatersheds due to the high IC and land uses associated with high pollutant loading (e.g., high traffic volumes). This includes Industrial Park South, Bear Brook North Branch and Bear Brook South Branch. (see Appendix III, Map S).



Refer to Appendix I, Map S.

4.2.3 CHLORIDE

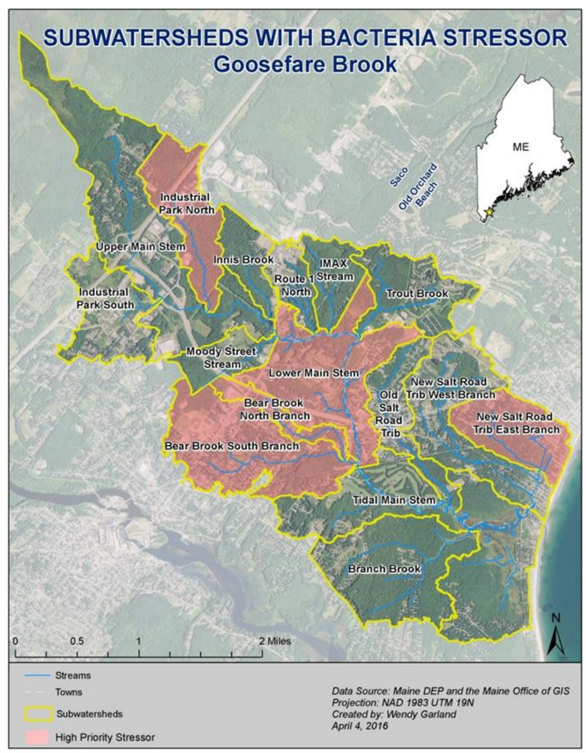
Seven subwatersheds have been identified as having chloride levels approaching or above levels toxic to aquatic life in the stream. Chloride is of primary interest to management because it represents a large source of pollutants from road salt application. The seven subwatersheds that have been identified as having elevated chloride levels are Upper Main Stem, Industrial Park North, Industrial Park South, Moody Street Stream, Route 1 North, Bear Brook North Branch and Bear Brook South Branch. (see Appendix III, Map T).



Refer to Appendix I, Map T.

4.2.4 BACTERIA

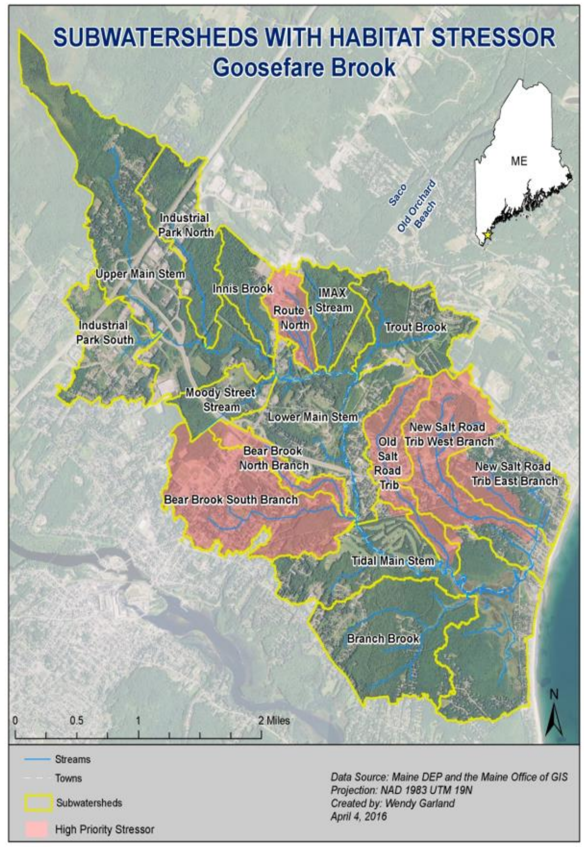
Bacteria levels are measured through testing *Escherichia coli* (*E. coli*) and Enterococcus, bacteria found in human and animal waste. Monitoring along Goosefare Brook and its tributaries revealed five subwatersheds as having highly elevated levels of bacteria that are also likely tied to human sources (Industrial Park North, Lower Main Stem, Bear Brook North Branch, Bear Brook South Branch, and New Salt Road East Branch). (See Appendix III, Map U).



Refer to Appendix I, Map U.

4.2.5 STREAM HABITAT

The 2015 Stream Corridor Assessment, SCA habitat assessment, Geomorphic Reconnaissance Survey, and the Fish Barrier Study provided information about stream habitat impacts and integrity. Based on these surveys, degraded stream habitat appears to be a contributing factor to aquatic life or water quality impacts in several subwatersheds. Three subwatersheds (Bear Brook North Branch, Bear Brook South Branch, Route 1 North) were identified as having significant stream habitat problems that likely impact aquatic life. Two addition subwatersheds (Old Salt Road Tributary and New Salt Road West Branch) had significant habitat issues but only along a relatively short stretch of stream. (see Appendix I, Map V).



Refer to Appendix I, Map V.

Various photos of the Goosefare Brook outlet and Old Orchard Beach PHOTO CREDIT: FBE

5 RESTORATION PLAN

Watershed studies and community stakeholder involvement provide an excellent framework for identifying and understanding the sources of pollution and habitat impairment in the Goosefare Brook Watershed. This information has led to the development of locally-driven solutions, organized and prioritized in an Action Plan (Sections 5.1.1 & 5.1.3). Successful restoration of the stream requires setting goals and developing objectives to help meet those goals. The following Restoration Plan provides key actions needed to restore the stream, the timing of these actions, and the mechanisms by which these actions will be accomplished.

Bear Brook Stream Cleanup

In early October, the Maine Conservation Corps, with help from Old Orchard Beach Campground and the City of Saco, conducted a clean-up of Bear Brook. Volunteers removed about 60 tires from where Bear Brook flows through the Old Orchard Beach Campground. Volunteer efforts such as this will be key to Goosefare Brook restoration.

Photo of staff and volunteers from the tire removal efforts in Bear Brook PHOTO CREDIT: Maine DEP.

5.1 GOALS AND OBJECTIVES FOR RESTORATION AND PROTECTION

The Goosefare Brook Steering Committee set the following goals for the WBMP:

- Improve Goosefare Brook water quality and habitat so it meets state standards and is safe for human contact.
- Protect the stream and its tributaries from current and future impacts.
- Raise public awareness and create and maintain community support for restoring Goosefare Brook.

These ambitious goals can only be achieved with the commitment of a coordinated group of local community leaders, conservation groups, state and federal partners, and citizens of the watershed working together to accomplish common goals and objectives.

5.1.1 ACTION PLAN TO PROTECT AND RESTORE WATER QUALITY AND HABITAT

The TAC identified the highest priority action items needed to address goals of protecting and restoring the stream from the major stressors in Goosefare Brook (nutrients, bacteria, chloride, toxics, and stream channel and corridor stressors). Table 7 provides a list of these action items, which are listed from high priority → low priority.

The two major categories of stream restoration activities are structural and non-structural BMPs. Structural BMPs are those that involve construction, installation, or other physical changes to the built environment or landscape. Typically, structural BMPs focus on reduction or treatment of stormwater by redirecting piped stormwater drainage to engineered soil and/or vegetative filter systems or natural vegetated areas, pervious pavement, or detention or retention ponds. Non-structural BMPs are those which involve operational changes, such as allowing natural vegetation to grow along stream banks rather than aggressively mowing, reducing fertilizer application, optimizing de-icing procedures to use the minimum amount of salt necessary, relocating snow dumps to less sensitive areas, regular street sweeping, and maintaining existing stormwater treatment systems. A combination of structural and non-structural BMPs is usually the most effective.

Table 7. Action plan for the Goosefare Brook watershed.

Goals: Improve Goosefare Brook water quality and habitat so it meets state standards and is safe for human contact. Protect the stream and its tributaries from current and future impacts.			
ACTION	**HOW**	**WHO**	**WHEN**
NUTRIENT STRESSORS			
(1) Implement Stormwater Infiltration and Treatment Retrofits	See Retrofit Prioritization Table. Identify additional high priority retrofits in OOB and Saco.	City of Saco/Town of OOB; Consultants and Engineers	Phase I by 2026; Phase II by 2031 (as needed)
(2) Increase Stream Buffer Protection (and Restoration)	Restore stream buffers in targeted hotspots identified during the 2015 Geomorphic Assessment and the Stream Corridor Survey.	City of Saco/Town of OOB/YCSWCD	Phase I by 2026; Phase II by 2031 (as needed)
(3) Improve Local Land Use and Development Ordinances	Improve ordinances for both new development and redevelopment	City of Saco/Town of OOB	2016-2020
(4) Raise Public Awareness and Education	Specifically raise awareness with regard to fertilizer and pesticide application and disposal of lawn waste. Encourage residents to use natural landscapes.	City of Saco/Town of OOB	Ongoing
(5) Create Nutrient Management Plans	Provide recognition and/or awards and demonstration sites to promote nutrient management. Target large landowners in the watershed (ex. golf courses, schools, campgrounds).	City of Saco/Town of OOB/YCSWCD	2017-2018
(6) Targeted Workshops and Demonstration Sites	Host target workshops and demonstration sites in high-risk neighborhoods/areas.	City of Saco/Town of OOB	2017-2018
(7) Inventory and Encourage increased Frequency of Street Sweeping on Commercial Properties	Encourage commercial businesses to increase sweeping of their streets and parking areas.	City of Saco/Town of OOB, Businesses, Maine DOT, Maine Turnpike Authority	2016 - 2031
(8) Reduce Impervious Cover	Reduce IC from both new and existing development.	City of Saco/Town of OOB	Ongoing
(9) Increased Monitoring of Erosion and Sediment Controls	Increase monitoring of erosion and sediment controls in new development.	City of Saco/Town of OOB; Consultants; Maine DEP	Ongoing

Goals: Improve Goosefare Brook water quality and habitat so it meets state standards and is safe for human contact. Protect the stream and its tributaries from current and future impacts.			
ACTION	**HOW**	**WHO**	**WHEN**
BACTERIA STRESSORS			
(1) Find and Fix Sources of Bacteria	Continue working to isolate and remove sources of bacteria within the watershed.	City of Saco/Town of OOB; Maine Healthy Beaches	Ongoing
(2) Promote Septic System Maintenance	Pursue changes in local ordinances and tax incentives for septic maintenance *(OOB currently has tax breaks for septic pumping).*	City of Saco/Town of OOB	2020
(3) Continue to Prioritize Municipal Diligence and Maintenance	Sewer pipe maintenance and upgrades to enable quick problem detection and fixes.	City of Saco/Town of OOB	Ongoing
(4) Incentivize Hookups to Public Sewer through Amnesty or Grant Funding	Encourage community members with old septic systems to connect to public sewer - specifically in Old Orchard Beach	City of Saco/Town of OOB	Ongoing
(5) Educate Public about Proper Pet Waste Disposal and Provide Better Disposal Options	Host pet waste awareness events, such as "April Stools Day". Add trash cans and bags in key areas for pet waste disposal.	City of Saco/Town of OOB	Ongoing
(6) Increase Stream and Watershed Signage	Add stenciling to catch basins and overall increase signage in the watershed (ex. 'Report Dumping', 'Protect Goosefare Brook', 'Pick up Pet Waste')	City of Saco/Town of OOB	By 2020
CHLORIDE STRESSORS			
(1) Promote Reduced Salt Application in Hotspot Areas	Targeted outreach to landowners in hotspots to examine salt use and BMP adjustments (ex. seasonal valve on BMPs to limit stormwater access to infiltration BMPs). Install signage to identify "reduced salt" areas and encourage proper application rates.	City of Saco/Town of OOB	By 2020
(2) Encourage Equipment Calibration	Ensure that contractors and municipalities are properly calibrating their instruments and applying brining and pre-wetting techniques when it is helpful.	City of Saco/Town of OOB Landowners and Contractors/ Maine Load Roads	Ongoing
(3) Train Road Salt Applicators	Train contractors/appliers with the goal of eventually participating in a program such as the Green SnowPro program in New Hampshire.	City of Saco/Town of OOB; Landowners and Contractors; State of Maine/Maine Local Roads	NA

Goals: Improve Goosefare Brook water quality and habitat so it meets state standards and is safe for human contact. Protect the stream and its tributaries from current and future impacts.			
ACTION	**HOW**	**WHO**	**WHEN**
(4) Identify and Install BMPs that Protect Groundwater in Hotspots	Isolate meltwater from groundwater in hotspots to protect the groundwater from chloride inputs; for example, using an off-line BMP or a valve.	City of Saco/Town of OOB; Consultants and Engineers	2020-2026
(5) Secure Stormwater Infrastructure	Secure stormwater infrastructure to prevent leaking of high chloride stormwater into the groundwater.	City of Saco/Town of OOB	Ongoing
(6) Promote Use of Heated Sidewalks	Install signage to improve public visibility of existing heated sidewalks (e.g., Saco train station, Dyer Library). Provide tax incentives and outreach for new businesses with heated sidewalks.	City of Saco/Town of OOB	By 2020
TOXIC STRESSORS			
(1) Conduct Remediation for Legacy Toxics	Ensure that any ongoing legacy toxics identified in 2016 EPA study of upper watershed (Saco Steel area) are addressed.	City of Saco; Maine DEP; EPA	2016 - 2026
(2) Implement Stormwater BMPs that Remove Toxics	See Retrofit Prioritization Table for BMPs treating toxics at hotspots within the watershed. Identify additional priority retrofits in OOB and Saco.	City of Saco/Town of OOB	2016 – 2020
(3) Develop Local Ordinances that Require BMPs for Businesses with High Toxic Export	Require high vehicle use businesses (e.g., drive-thrus) to install BMPs that address toxics	City of Saco/Town of OOB; Landowners	2016 - 2020
(4) Promote Low-Chemical Lawn Care Practices	Conduct business and residential outreach on lawn herbicide and pesticide use.	City of Saco/Town of OOB; Landowners	Ongoing
(5) Increase Catch Basin Cleaning and Street Sweeping	**MUNICIPAL:** Maintain annual catch basin cleaning for all catch basins and twice annual catch basin cleaning in priority subwatersheds in Saco. Maintain a minimum of twice annual street sweeping. **PRIVATE:** Encourage a minimum of twice annual catch basin cleaning and street sweeping on commercial properties within the watershed.	City of Saco/Town of OOB; Commercial Businesses	Ongoing
(6) Promote Vehicle Maintenance through Public Outreach	Promote vehicle maintenance to reduce toxics from exhaust, as well as tire maintenance.	City of Saco/Town of OOB; Landowners	Ongoing

Goals: Improve Goosefare Brook water quality and habitat so it meets state standards and is safe for human contact. Protect the stream and its tributaries from current and future impacts.			
ACTION	**HOW**	**WHO**	**WHEN**
STREAM HABITAT			
(1) Implement Recommendations from 2015 SCA and Geomorphic Assessments	Carry out recommendations made in the 2015 Geomorphic Assessment to address priority erosion, buffer, yard waste, channel alteration, and geomorphological problems.	City of Saco/Town of OOB; Consultants; Maine DEP; YCSWCD	Phase I by 2026; Phase II by 2031 (as needed)
(2) Extend Shoreland Zoning to Protect Small Streams	Require and enforce shoreland zoning for first order streams. Action item would include mapping of first order streams.	City of Saco/Town of OOB	2016 – 2026
(3) Pursue Conservation Easements	Seek to obtain conservation easements for high quality sections of Goosefare Brook as available.	City of Saco/Town of OOB; RCWR; SVLT	2016 - 2026
(4) Remove Fish Barriers	Remove fish barriers identified by USFWS. Prioritize and address potential barriers.	City of Saco/Town of OOB; Consultants; Maine DIFW, Maine DOT, Maine Turnpike Authority	2016 - 2020
(5) Conduct Outreach to Stream Abutters	Educate landowners abutting Goosefare Brook and its tributaries.	City of Saco/Town of OOB	Ongoing
(6) Protect and Restore Salt Marsh	Promote salt-water exchange and remove isolated stands of Phragmites.	City of Saco/Town of OOB; RCWR; SVLT	2018 - 2020

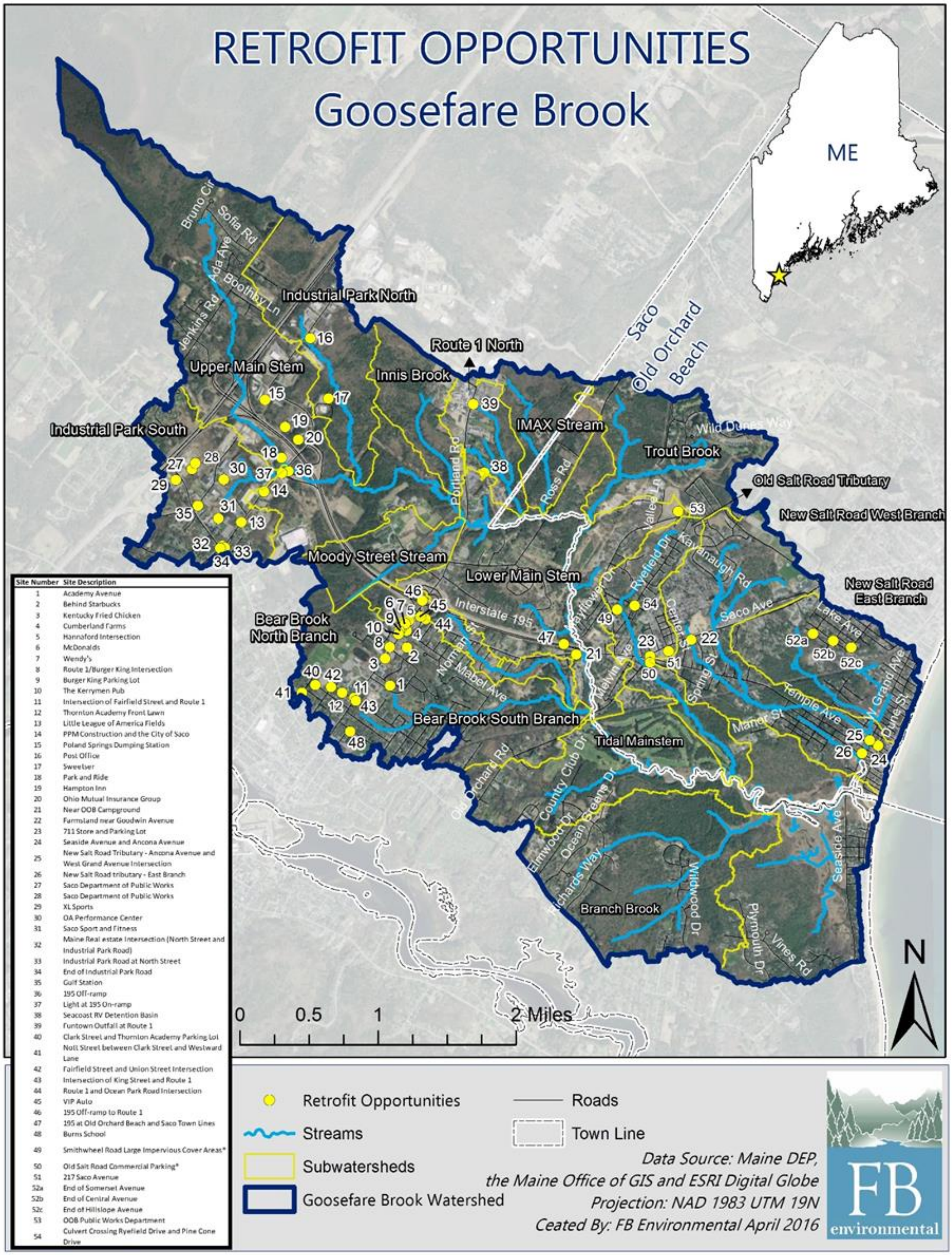
5.1.2 PRIORITIZATION OF RETROFIT SITES

A retrofit reconnaissance survey was conducted across multiple days in November and December of 2015. The retrofit survey was coordinated by FB Environmental and working groups were a combination of members from the TAC. The retrofit survey focused on the priority subwatersheds with nutrient and toxic stressors that could be addressed, in part, by stormwater retrofits. (Note that stormwater was not identified as a priority source of bacteria, so these subwatersheds were not targeted in the retrofit survey.) The target area included Industrial Park South, Bear Brook South Branch, Bear Brook North Branch. A few additional retrofits were identified in the Upper Main Stem, Industrial Park North, Route 1 North, the Lower Main Stem, and New Salt Road West Branch in Old Orchard Beach. Following survey completion, the TAC for the Goosefare Brook WBMP developed ranking criteria to prioritize the sites proposed for new BMPs, as well as retrofits to existing BMPs. Table 8 outlines the criteria that were used to prioritize the BMPs listed in the following table (Table 9).

The action plan proposes work in at least two phases. Phase I outlines actions that address sources linked to priority stressors in impaired subwatersheds and actions that provide multiple stream protection benefits. This phase is expected to bring the stream into or close to attainment and has a target completion date of 2026. Phase II actions may be needed if Phase I does not result in stream restoration, and the actions are also important to protect the stream from further degradation. Phase II targets lower priority pollution sources that may be linked to stream impairment or provide stream protection benefits from secondary stressors. The action plan is separated into Phase I and Phase II implementation categories based on the retrofit ranking feedback provided by the TAC, using a total ranking score of '20' to identify Phase I retrofits. This division was used to address all BMPs in the high priority subwatersheds in Phase I to maximize the probability of attainment. Planning level cost ranges were also developed for most sites. It should be noted that costs could be significantly lower if local municipal resources are used for design and construction. Phasing the plan also helps to distribute the costs across a longer time scale and across both municipalities as possible to ease the financial burden of implementation.

Table 8: Retrofit Ranking Criteria developed by the TAC to prioritize retrofits

RETROFIT RANKING CRITERIA															
CRITERIA 1 Stream Restoration- Protection Benefit				**CRITERIA 2 BMP Effectiveness**				**CRITERIA 3 Retrofit Feasibility**				**CRITERIA 4 Public Benefit and Education**			
(Max. 15 POINTS)				**(Max. 5 POINTS)**				**(Max. 5 POINTS)**				**(Max. 5 POINTS)**			
Priority Watershed	Yes: 5 No: 0 U. Main Stem = 2	Hotspot Land Use	High: 10 Med-High: 8 Med: 6 Low: 4 Lower: 2 None: 0	BMP Feasibility	High: 2 Low: 1	Maintenance	Low: 3 High: 1	Ownership	Public: 3 Private: 1	Implementation	Easy: 2 Hard: 1	Public Health	Threat: 2 No Threat: 0	Awareness/Visibility	High: 3 Low: 1



Site Number	Site Description
1	Academy Avenue
2	Behind Starbucks
3	Kentucky Fried Chicken
4	Cumberland Farms
5	Hannaford Intersection
6	McDonalds
7	Wendy's
8	Route 1/Burger King Intersection
9	Burger King Parking Lot
10	The Kerrymen Pub
11	Intersection of Fairfield Street and Route 1
12	Thornton Academy Front Lawn
13	Little League of America Fields
14	PPM Construction and the City of Saco
15	Poland Springs Dumping Station
16	Post Office
17	Sweetser
18	Park and Ride
19	Hampton Inn
20	Ohio Mutual Insurance Group
21	Near OOB Campground
22	Farmland near Goodwin Avenue
23	711 Store and Parking Lot
24	Seaside Avenue and Ancona Avenue
25	New Salt Road Tributary - Ancona Avenue and West Grand Avenue Intersection
26	New Salt Road tributary - East Branch
27	Saco Department of Public Works
28	Saco Department of Public Works
29	XL Sports
30	OA Performance Center
31	Saco Sport and Fitness
32	Maine Real estate Intersection (North Street and Industrial Park Road)
33	Industrial Park Road at North Street
34	End of Industrial Park Road
35	Gulf Station
36	195 Off-ramp
37	Light at 195 On-ramp
38	Seacoast RV Detention Basin
39	Funtown Outfall at Route 1
40	Clark Street and Thornton Academy Parking Lot
41	Noll Street between Clark Street and Westward Lane
42	Fairfield Street and Union Street Intersection
43	Intersection of King Street and Route 1
44	Route 1 and Ocean Park Road Intersection
45	VIP Auto
46	195 Off-ramp to Route 1
47	195 at Old Orchard Beach and Saco Town Lines
48	Burns School
49	Smithwheel Road Large Impervious Cover Areas*
50	Old Salt Road Commercial Parking*
51	217 Saco Avenue
52a	End of Somerset Avenue
52b	End of Central Avenue
52c	End of Hillslope Avenue
53	OOB Public Works Department
54	Culvert Crossing Ryefield Drive and Pine Cone Drive

Refer to Appendix I, Map W.

Table 9. Table of retrofit prioritization including the site, site description, BMP recommendation, cost and total ranking score developed from the TAC criteria. Sites are ordered from highest priority → lowest priority.

Ranking	Site Number	Site Description	Sub-Watershed	Proposed BMP	Cost Range	Total Ranking Score
Phase I						
1	5B	Hannaford/I-195	Bear Brook North	Add a gravel wetland between the ramp and I-195 (Maine DOT responsibility)	$250,000 to $300,000	27
2	11A	Intersection of Fairfield Street and Route 1	Bear Brook South	Add a curb cut into the low area at the corner of Fairfield OR add a tree box filter on the sidewalk	$15,000 - $20,000	26
3	23	Saco Ave, Temple Ave, Old Orchard Road Intersection	Old Salt Road Tributary	Installation of bioretention systems, tree box filters or other treatment options to improve nutrient loading and/or thermal impacts	TBD	25
4	5A	Hannaford Intersection	Bear Brook South	12' x 8' tree box filters (in the sidewalk along Wendy's corner)	$35,000 - $40,000	24
5	33	Ind. Park Rd at North St.	Industrial Park South	Catch basin insert	<$1,500	24
6	44	Route 1/Ocean Park Intersection	Bear Brook South	Bioretention system	$15,000 - $20,000	24
7	46	195 Off-ramp to Route 1	Bear Brook North	Gravel wetland (Maine DOT responsibility)	$15,000 - $20,000	24
8	3	KFC	Bear Brook South	Add tree box filter in Front of KFC to treat the southbound lane of Route 1	$15,000 - $20,000	23
9	4	Cumberland Farms	Bear Brook South	Underdrain to filter basin currently exists, but potentially could be improved	TBD	23
10	11B	Intersection of Fairfield and Route 1	Bear Brook South	Add tree box filter on Fairfield Street on the catchments by the intersection	$20,000 - $30,000	22

Table 9 (cont'd)

Ranking	Site Number	Site Description	Sub-Watershed	Proposed BMP	Cost Range	Total Ranking Score
11	12	Thornton Academy Front Lawn	Bear Brook South	1. Add an infiltration trench or underdrain filter along the front edge of the lawn with the Gazebo. Add curb cuts along the road. 2. Add an underdrain along the edge of the parking lot OR add a Tree Box filter	$15,000 - $20,000	22
12	22	Farm stand near Goodwin Ave	Old Salt Road Tributary	New road material; level spreader; divert away from the stream	$12,000 - $15,000	22
13	8	Route 1/Hutchins	Bear Brook South	Add one tree box filter on the corner of Route 1 and Hutchins OR Drop a storm drain and put a pipe across the road to the grass area by Pizza Hut.	$20,000 - $50,000	21
14	18	Park and Ride	Upper Main Stem	Tree box filter OR other filtration BMP	$15,000 - $20,000	21
15	32	Maine Real Estate Intersection (North St. and Ind. Park Rd)	Industrial Park South	Bioretention system	$15,000 - $20,000	21
16	34	End of Industrial Park Rd	Industrial Park South	Tree box filters (one or two)	$15,000 - $40,000	21
17	36	I95 off-ramp	Upper Main Stem	Bioretention system	$10,000 - $15,000	21
18	47	195 at OOB/Saco Line	Lower Main Stem	Infiltration and stone berms to promote ponding	$2,000 - $5,000	21
19	48	Burns School	Bear Brook South	Bioretention system	$10,000 - $15,000	21
20	26	Randall Shuffleboard Parking and Temple Ave	New Salt Road W. Branch	Grass pavers; rain garden at corner of West Grand and Temple Avenue	$10,000 - $12,000	20
21	29	XL Sports - IPS3	Industrial Park South	Multiple pond system: retrofit pond at the outlet structure and add a cell	$5,000 - $10,000	20

Table 9 (cont'd)

Ranking	Site Number	Site Description	Sub-Watershed	Proposed BMP	Cost Range	Total Ranking Score
22	31	IPS1 - Saco Sport and Fitness	Industrial Park South	Level spreader to vegetated meadow buffer	$3,000 - $4,000	20
23	41	Nott Street (Clark to Westward)	Bear Brook South	Enhance esplanade swales with underdrain swale or sand filter	$10,000 - $12,000	20
24	49	Smithwheel large Impervious areas and parking lots	Old Salt Rd Tributary	Tree box filters, vegetative cover and/or bioretention systems to provide nutrient and thermal treatment	TBD	20
25	50	Commercial Parking Lots – Old Salt Road	Old Salt Rd Tributary	Increase buffer and install stormwater BMPs to treat direct runoff from parking areas	TBD	20
26	51	Car Wash at 217 Saco Ave.	Old Salt Rd Tributary	Collect and direct car wash water at exit to sewer system, install filter system to treat stormwater runoff from excessive nutrients	TBD	20
27	52	Hillside/Central/Somerset Ave	Old Salt Rd Tributary	Install BMPs at dead end roadways for treatment of sheet flow runoff	TBD	20
28	39	Funtown outfall at Route 1	Route 1 North	Add a wet extended detention pond at the outfall for flow (for channel protection)	$50,000 - $60,000	20
				PHASE I SUBTOTAL	**$558,500 - $749,500**	
Phase II						
29	6	McDonalds	Bear Brook South	Tree box filter (remove 1 parking space) OR level the other side	$20,000 - $30,000	19
30	7	Wendy's	Bear Brook South	Install a 2" lip around the catch basin at Wendy's. Move the manhole and remove the high area and direct water to that location.	$10,000 - $12,000	19
31	15	Industrial Park Rail Side Lot	Upper Main Stem	Wet pond (extended detention)	$20,000 - $30,000	19
32	35	Gulf Station	Industrial Park South	Bioretention system	$10,000 - $15,000	19
33	37	Light at 195 Onramp	Upper Mainstem	Tree box filter	$15,000 - $20,000	19

Table 9 (cont'd)

Ranking	Site Number	Site Description	Sub-Watershed	Proposed BMP	Cost Range	Total Ranking Score
34	42	Fairfield and Union Intersection	Bear Brook South	Relocate curb and install bioretention system in layer esplanade	$15,000 - $20,000	19
35	53	OOB DPW	Old Salt Road Tributary	Install underdrained soil filter, tree box filters at parking lot areas prior to discharge into drainage ditch line	TBD	19
36	54	Ryefield Drive/Pine Cone Drive	Old Salt Road Tributary	Install tree box filters to treat runoff at headwaters of tributary	TBD	19
37	1	Academy Ave	Bear Brook South	Bioretention system (tree box filter if curbing was an option)	$35,000 - $40,000	18
38	2	Behind Starbucks	Bear Brook South	Further investigation needed - space limited	$10,000 - $12,000	18
39	40B	Fairfield Street T.A. Parking Lot	Bear Brook South	Bioretention system	$30,000 - $40,000	18
40	9	Burger King	Bear Brook South	Add one tree box filter at the end of the Burger King parking area. Have this bypass to Route 1 when it is backed up.	$20,000 - $30,000	17
41	10	Kerrymen Pub Burger King Drive-thru	Bear Brook South	Add a small tree box filter between Burger King and Kerrymen Pub OR remove the drive-thru exit.	$20,000 - $30,000	17
42	30	OA Sports Center	Industrial Park South	Bioretention system	$60,000 - $70,000	17
43	40A	Clark Street and T.A. Parking Lot	Bear Brook South	Bioretention system	$5,000 - $10,000	17
44	2A	Behind Dunkin Donuts and Pizza Hut	Bear Brook South	Every 10 ft. put curb cut and install a swale OR Remove pavement in back (second row) and direct water into this area	$27,000 - $30,000	16
45	14	PM - Construction and the City of Saco	Upper Main Stem	Add 100 ft. of a grassed underdrain soil filter (GUSF)	$5,000 - $8,000	16

Table 9 (cont'd)

Ranking	Site Number	Site Description	Sub-Watershed	Proposed BMP	Cost Range	Total Ranking Score
46	27	Saco DPW	Industrial Park South	Gravel wetland	$200,000 - $250,000	16
47	43	King Street and Route 1	Bear Brook South	Two tree box filters	$30,000 - $40,000	16
48	45	VIP Auto	Bear Brook South	Bioretention system	$40,000 - $50,000	16
49	24	Seaside and Ancona	New Salt Road W. Branch	Tree box filters on both sides of the road (or rain gardens).	$30,000 - $40,000	15
50	13	Little League of America	Industrial Park South	Add a wet pond	$20,000 - $30,000	14
51	28	DPW	Industrial Park South	Gravel wetland - after or during redevelopment.	TBD (only if redeveloped)	14
52	39	Funtown outfall at Route 1	Route 1 North	Add a wet extended detention pond at the outfall for flow (for channel protection)	$60,000 - $80,000	14
53	16	Post Office	Industrial Park North	Retrofit existing pond and make it into multiple basins	$15,000 - $20,000	13
54	17	Sweetser	Industrial Park North	Option to retrofit pond	$15,000 - $20,000	13
55	19	Hampton Inn	Upper Main Stem	Possible retrofit of wet pond	$15,000 - $20,000	11
56	20	Ohio Mutual Insurance Group	Upper Main Stem	Tree box filter at the catch basin	$20,000 - $30,000	10
57	25	Ancona Ave and West Grand Ave Intersection	New Salt Road W. Branch	Tree box filter	$20,000 - $30,000	8
58	38	Seacoast RV detention basin	Route 1 North	Basin retrofit for channel protection	$10,000 - $15,000	8
				PHASE II SUBTOTAL	$777,000 - $1,022,000	
				GRAND TOTAL	**$1,355,500 - $1,771,500**	

Additionally, Table 10 provides a summary of the Action Plan for the restoration sites identified during the 2015 Stream Corridor Assessment and Geomorphic Assessment.

Table 10: Stream Corridor Restoration Site Action Plan

Phase I	# Sites	Sites Descriptions	Cost
Erosion Sites	13	E1, 3, 9, 10, 13, 14, 15, 25, 26, 35-38	$55,000
Buffer Sites	16	B1, 3, 4, 5, 6, 12, 13, 22, 24-29, 31, 33	$23,000
Dumping Sites	4	D1, 7, 11, 12	$2,000
Channel Alteration Sites	5	CA1, 10, 11	$15,000
Geomorphology Sites	2	Upper Bear Brook, Lower Bear Brook	$30,000
		PHASE I TOTAL:	$125,000
Phase II	**# Sites**	**Sites Descriptions**	**Cost**
Fish Barriers	2	Rt. 5, Ind. Park Rd.	$50,000
Erosion Sites	12	E2, 3, 4, 7, 8, 11, 16, 21, 22, 27, 32, 39, 40, 41, 43, 44	$27,000
Buffer Sites	10	B2, 7, 8, 9, 18, 19, 21, 23, 30, 32	$15,000
Dumping Sites	4	D2, 3, 4, 9	$3,000
Channel Alteration Sites	3	CA5, 7, 9	$15,000
Geomorphology Sites	1	Ross Road	$15,000
		PHASE II TOTAL:	$125,000

5.1.3 ACTION PLAN TO RAISE PUBLIC AWARENESS AND COMMUNITY SUPPORT

Public awareness and support are critical to Goosefare Brook's restoration and protection. To gage existing awareness and support for Goosefare Brook, Thornton Academy students conducted an intercept survey on June 9, 2015. An intercept survey involves surveying members of the community at random during their daily routine (i.e. "intercept" people during their routine schedule). Individuals were 'intercepted' at the Saco and Old Orchard Beach polling stations in conjunction with the School Budget Referendum Election. Sixty-six percent of individuals surveyed were from Saco and 34% of individuals were from Old Orchard Beach, with 52% of responses from males and 48% of responses from women. The most surveyed age group was from ages 55-64.

Overall, 48% of those surveyed were "very concerned" with the quality of Goosefare Brook and another 23% were "somewhat concerned". When asked to identify pollutants of concern found in stormwater runoff, common answers were regarding oils, gases, chemicals, trash, septic leakage and sewer, bacteria, plastic, toxic wastes, and many more. Furthermore, 67% of those surveyed had heard of the Goosefare Brook Improvement Project, indicating that the community is steadily becoming aware of the concerns regarding Goosefare Brook. Specifically, individuals were concerned about toxic chemicals (67%), bacteria (65%), and the health of animals living the stream (64%). Further information is available in the Goosefare Brook Intercept Survey.

Although this is a solid starting point, the WBMP provides several other actions for building and maintaining this support over time. Note that additional education and outreach actions tied to specific stressors are already listed in Table 7. Table 11 lists recommendations, potential partners, timeframes, and costs in two categories.

Administrative & Funding action items are a vital part of bringing both structural and non-structural BMP recommendations to fruition. Obtaining additional funding should be a high priority throughout plan implementation, and both municipalities should be aware of and apply for funding opportunities as they arise.

Education & Outreach action items will promote awareness of the connection between land use, water quality, and stream health. Therefore, efforts should focus on engaging community groups, businesses, City/Town maintenance crews, residents, and school groups.

Table 11. Action Items for Raising Public Awareness and Community Support

Goal: Raise public awareness and create and maintain community support for restoring Goosefare Brook.				
ACTION	**HOW**	**WHO**	**WHEN**	**COST**
ADMINSTRATIVE & FUNDING				
(1) Ensure that there is sufficient organizational structure to enact plan	Adopt the Goosefare Brook Watershed Management Plan. Form the Goosefare Brook Restoration Workgroup.	Saco & OOB; YCSWCD	2016	NA
(2) Apply for funding	Apply for state and federal grants and/or seek other funding to support implementation of planning recommendations.	Saco & OOB	Ongoing/Current	In House
(3) Work with private landowners and state agencies for funding support for BMP implementation	Work with private landowners and the Maine DOT to ensure proper and timely implementation of the recommended BMPs at their site. Develop a method of tracking and monitoring BMP implementation progress.	Saco & OOB, Private Landowners	2016-2026	$500/yr.
(4) Ensure that there is sufficient support to enact plan	Develop an annual work plan (and publish it to the public) by anniversary date of approved WMP. Ensure sufficient staff support to implement programs, enforce ordinances, oversee construction, implementation of BMPs, and education programs.	Saco & OOB	2016-2021	$11,000
EDUCATION & OUTREACH				
(1) Garner support and cooperation from different community groups and agencies	Contact civic organizations within the City of Saco and Town of OOB and work with these groups to raise awareness about stream restoration.	ME Healthy Beaches, Saco, OOB, OOB Con. Com., SVLT	2016-2026	In House
	Organize stream and beach clean-up days with local volunteers from the community.	ME Healthy Beaches, OOB Con. Com., SVLT, Volunteers	Ongoing	In House

Table 11(cont'd)

Goal: Raise public awareness and create and maintain community support for restoring Goosefare Brook.				
ACTION	**HOW**	**WHO**	**WHEN**	**COST**
(2) Engage Citizens and Students in stream restoration efforts	Organize an educational event for families that live in the Goosefare Brook Watershed. This may include a hands-on outdoor event with water in the summer (e.g. identifying macroinvertebrates) or a walking tour through the estuarine section in the Rachel Carson Wildlife Refuge.	Saco & OOB, Maine DEP, Consultants, Rachel Carson, Volunteers	2016-2020	$250/yr.
	Develop yearly one-page fact sheet to update residents about restoration projects and educate residents on proper "housekeeping," including use of sand, salt, sealants, fertilizers, pesticides, trash, recycling, etc.	Saco & OOB	2016-2026	$500/yr.
	Establish a BMP demonstration site for residents to visit in a high-visibility, hotspot neighborhood. One example would be signage at the Thornton Academy front lawn.	Town of Saco & OOB (with help from ME Healthy Beaches, OOB Con. Com,)	2016-2020	$500 (signage for the BMP)
	Conduct watershed education at local schools.	Maine DEP, Consultants, Local Schools, YCSWCD	2016-2026	$100/yr.
#3: Incorporate the Goosefare Brook Action Plan into the City Comprehensive Plan	1) Support landscaping waste pick-up program as well as street sweeping on municipal roads and commercial parking areas.	Saco & OOB	Ongoing	In House
#4: Extend shoreline zoning rules to protect more riparian habitat adjacent to impaired streams	1) Conduct fertilizer survey of watershed to determine what portions of the residential lawns are fertilized and by how much annually.	Saco & OOB (with help from Consultants)	2016-2018	$5,000

5.2 POLLUTANT REMOVAL

FB Environmental conducted a pollutant loading analysis to estimate the pollutant load reductions to the stream from the recommended BMPs. Estimated load reductions are for total suspended sediments (TSS), total phosphorus (TP), and total nitrogen (TN) loading to the stream (Table 12). Each BMP was evaluated using the Region 5 model and was assigned pollutant load reduction numbers. Retrofits to existing infrastructure (such as updating wet ponds) are NOT included in this analysis as further engineering design is needed to estimate pollutant load reductions. After each BMP was analyzed, pollutant reduction calculations were aggregated by subwatershed for simplicity. BMP retrofit sites were located in ten different subwatersheds (Upper Main Stem, Industrial Park North, Industrial Park South, Route 1 North, Bear Brook North, Bear Brook South, Lower Main Stem, New Salt Road West Branch and Old Salt Road) listed in Table 12. Industrial Park North, Old Salt Road and the Lower Main Stem are listed in this table because they contain retrofit sites, however, these sites currently do not have estimated pollutant load reduction values (NA).

Caution should be used when interpreting the modeled pollutant loading values as these values may change with a more thorough evaluation of the site-specific runoff and soil infiltration rates by a qualified engineering firm. The pollutant loading values have been calculated using the US EPA Region 5 model but should be used as guidelines in the planning and decision-making process.

Table 12. Pollutant load reductions listed for the nine subwatersheds containing retrofit sites. Subwatersheds are listed from upstream → downstream as possible.

		LOAD REDUCTIONS (LBS/YR)		
SUBWATERSHED	**BMP RECOMMENDATIONS**	**TSS**	**TP**	**TN**
Upper Main Stem	*Three tree box filters, two wet detention ponds, and one grassed underdrain soil filter.*	1886	1	16
Industrial Park North	*Retrofits to existing ponds*	NA	NA	NA
Industrial Park South	*Two tree box filters, three bioretention areas, one catch basin filter, two detention ponds, two gravel wetlands, and one vegetated buffer*	11,689	8	85
Route 1 North	*Two new ponds/detention basins.*	3,965	3	41
Bear Brook North	*Two gravel wetlands*	12,839	6	19
Bear Brook South	*Eight bioretention areas, one gravel wetland, one infiltration trench, three swales or re-direction of stormwater to a grassed underdrain area, pavement removal, and up to eleven tree box filters.*	11,529	10	123
Lower Main Stem	*Amendments to shoulder to promote ponding/infiltration (potential issue with salt application to road)*	NA	NA	NA
Old Salt Road	*Tree box filters, bioretention areas, underdrained soil filter and buffer plantings*	NA	NA	NA
New Salt Road West Branch	*Three tree box filters, replace parking lot with grass pavers, two bioretention areas, and replace road material with porous pavement.*	574	0	9
	TOTAL LBS/YR REDUCED	**42,482**	**28**	**293**

**Load reductions are estimates only and are based off the US EPA Region 5 model for estimating urban runoff load reductions due to BMP installation.*

6 IMPLEMENTING THE PLAN

6.1 PLAN OVERSIGHT & ADOPTION

The Goosefare Brook Restoration Committee will be formed to administer the Goosefare Brook WBMP. The City of Saco and Town of Old Orchard Beach will take a lead role in convening the group and serve on the committee. Other stakeholders including elected officials, watershed business owners, and other interested groups will also be involved. The Committee will meet at least two to four times each year to provide periodic updates to the plan, track and record progress made toward restoration, maintain and sustain action items, and make the plan relevant on an ongoing basis by adding new tasks as needed. The Committee should track achievements, press coverage, outreach activities, number of retrofits sites repaired, number of volunteers, and amount of funding received.

The Plan may take 15 years or more to implement, depending on funding sources and availability. Sustainable funding, a good administrative process, and cooperation by partners and landowners are all variables that will lead to the success of the plan. If Goosefare Brook meets Class B water quality standards before implementation of recommended actions are complete, then the goal of the plan has been met.

Developing a funding plan, which garners the approval of the community, is essential to success. A community restoration effort should include the collaboration and support of the entire community, including local businesses and property owners, community groups, conservation groups, corporate sponsors, and municipalities. In some cases, it may be possible to attain additional state or federal grants to help implement the plan. Broad community support is a major strength when applying for such funding.

adoption of the plan by the municipalities is highly recommended to help raise local awareness about the need for restoration efforts and to garner support needed to implement various aspects of the plan.

6.2 ESTIMATED COSTS AND TECHNICAL ASSISTANCE NEEDED

The cost of successfully implementing the Goosefare Brook WBMP is estimated at approximately **$1,866,000 - $2,301,700** or approximately $140,000 per year over the course of the next 15 years (2016 – 2031) based on the recommended actions in Section 5.1. This includes structural BMPs (Section 5.1.2), non-structural BMPs (Section 5.1.3), and monitoring efforts (discussed further in Section 7.2). This general 'best guess' estimate is based on the following assumptions in Table 13 on the page 62.

Table 13. Estimated 15-year cost for restoring Goosefare Brook.

15-YEAR COST ESTIMATE FOR RESTORING GOOSEFARE BROOK		
Category	**Estimated Annual Costs**	**15-year Total**
Structural BMPs		
Stormwater Retrofit Sites[5]	$90,367 - $118,100	$1,355,500 - $1,771,500
Stream Corridor Restoration	$16,667	$250,000
Retrofit Maintenance	$4,333 - $5,647	$65,000 - $84,700
Non-Structural BMPs		
Administrative & Funding	$1,067	$16,000
Education & Outreach	$767	$11,500
Municipal Maintenance	$167	$2,500
Land Use Planning and Conservation	$2,000	$30,000
Source Control	$1,200	$18,000
Monitoring Program		
Monitoring	$7,833	$117,500
GRAND TOTAL (15-yr)	**$124,401 - $153,448**	**$1,866,000 - $2,301,700**

Restoration efforts should be funded by all aspects of the community, including local businesses and property owners, community groups, conservation groups, corporate sponsors, the City of Saco, and the Town of Old Orchard Beach. It is anticipated that each municipality would take the lead on seeking and contributing funding to specific projects located in their respective communities. However, joint programs or high priority sites could be jointly funded.

Stormwater Retrofits: State and federal agencies, such as the Maine DEP, Maine DOT, and USEPA, offer competitive grant programs to implement high-priority stormwater retrofits in the watershed and in-stream restoration efforts, as well as select education and outreach activities. See Section 7.1 "Maintaining a Funding Mechanism" for grant opportunities to implement stormwater retrofits.

Municipal Maintenance: Actions such as culvert repair, enhanced storm drain cleanout, and street sweeping programs, as well as ordinance revisions, should be supported by both municipalities. Other funding sources, such as local planning grants, may help supplement these projects.

Land Conservation: Conserving undeveloped land in the Goosefare Brook watershed is of great importance to protect the watershed from further development. Both municipalities should work closely with the Saco Valley Land Trust and the Rachel Carson Wildlife Refuge to obtain additional land for conservation with a particular focus on large tracts of forest and land adjacent to wetlands. Long-term land conservation efforts will need the support of local conservation groups, conservation enthusiasts, and individual donors to prevent poorly-planned development and long-term degradation of water quality in the watershed. Options such as obtaining easements within the riparian areas on the stream should be considered in lieu of outright purchase. Utilizing conserved lands for public trail systems and education kiosks are a good way to educate the public about watershed restoration efforts.

[5] Retrofit costs listed include both Phase I and II sites. Significant cost savings will be realized if restoration goals are met after Phase I sites are addressed. Phase I retrofit cost estimates range from $558,500 - $749,500.

Monitoring and Assessment: Future monitoring and assessment efforts will require a variety of funding sources, including the City of Saco, the Town of Old Orchard Beach, and private foundation grants.

7 METHODOLOGIES FOR MEASURING SUCCESS

While this plan provides specific goals and key actions needed to restore Goosefare Brook, it is inevitable that new information, technology, and techniques will be learned and developed in the years to come that may change the priorities of identified goals and actions. Therefore, the goals and priority of actions identified in this "living document" should be revisited and revised on an annual basis.

7.1 ADAPTIVE MANAGEMENT COMPONENTS

An adaptive management approach is widely recommended for restoring urban watersheds. Adaptive management enables stakeholders to conduct restoration activities in an iterative manner. This provides opportunities for utilizing available resources efficiently through BMP performance testing and restoration monitoring activities. Stakeholders can evaluate the effectiveness of one set of restoration actions and either adopt or modify them before implementing effective measures in the next round of restoration activities. The adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short-time frame (e.g., 2 years). Rather, adaptive management establishes an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration activities. Implementation of this approach will ensure that required restoration actions are implemented and that Goosefare Brook is monitored to document restoration over an extended period.

The adaptive management components of the Goosefare Brook WBMP will include:

- **CREATING AN ORGANIZATIONAL STRUCTURE FOR IMPLEMENTATION-** Since watershed restoration will require a considerable effort, key personnel and elected officials from the City of Saco and the Town of Old Orchard Beach should be officially appointed and be responsible for leading the Goosefare Brook Restoration Committee, which will be formed to administer the Goosefare Brook WBMP. Other stakeholders including elected officials, watershed business owners, and other interested groups will also be involved.
- **MAINTAINING A FUNDING MECHANISM-** The following list summarizes six possible outside funding options available to the Goosefare Brook restoration project. A combination of grant funding, private donations, and municipal funding must be used to ensure completion of the plan.

    US EPA/Maine DEP 319 Grants – This nonpoint source (NPS) grant is designed to assist municipalities with restoring waters named as NPS Priority Watersheds and are available for the implementation of watershed-based management plans. http://www.maine.gov/dep/water/grants/319.html

    US EPA Urban Waters Small Grants - The Urban Waters Small Grants program helps local residents and their organizations, particularly those in underserved communities, restore their urban waters in ways that also benefit community and economic revitalization. Grants are awarded every two years, with individual award amounts of up to $60,000. https://www.epa.gov/urbanwaters/urban-waters-small-grants

Five Star and Urban Waters Grants – Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Grants are awarded annually and range from $20,000 to $50,000 with an average size of $30,000. http://www.nfwf.org/fivestar/Pages/home.aspx

Clean Water Bond – Maine voters approved the Clean Water Bond in November 2012. Of the $10 million bond, $5.4 million will be used to upgrade stream crossings and culverts to help reconnect habitat for fish and other wildlife. http://www.maine.gov/dep/land/water_bond_rfp.html

Maine Coastal Program Grants – Municipalities and regional organizations in Maine's coastal zone are eligible to apply for small grants that provide funds for projects designed to improve water quality, increase resiliency and adaptation to erosion and flooding, conserve coastal habitat, promote sustainable development, and enhance the coastal-dependent economy while preserving natural coastal resources. In Fiscal Year 2016, $250,000 was awarded to eleven projects ranging from $5,000 - $48,000. http://www.maine.gov/dacf/municipalplanning/index.shtml

Compensation Fee Utilization Plan – The Stormwater Management Law authorizes the DEP to accept a compensation fee in lieu of meeting all or part of water quality standards, and Chapter 500, Section 6, establishes compensation fee requirements for projects located in the watersheds of urban impaired streams. Saco and Old Orchard Beach could elect to develop a compensation fee utilization plan (CFUP) that outlines eligible mitigation projects where compensation fee could be used. Several municipalities in Maine have adopted CFUPs and used fees to install BMPs identified in watershed-based plans. This arrangement could also be pursued for Goosefare Brook. Some communities have chosen to adopt the same fee structure for projects outside the urban impaired watershed boundary to eliminate the potential incentive to locating in the growth area.

Stormwater Utility Fee - A stormwater utility fee or similar revenue-generating structure is not currently envisioned for Goosefare Brook. However, this type of structure could be further explored if milestones and goals are not met as anticipated and additional stormwater retrofits and habitat restoration work is needed.

- **DETERMINING RESTORATION ACTIONS-** This plan provides a unified watershed restoration strategy with prioritized recommendations for restoration using a variety of methods, including structural, non-structural, in-stream, and riparian restoration actions. Both municipalities should use the proposed designs in this Plan as a starting point for current proposal writing and additional engineering for actual retrofit designs.
- **IMPROVING THE COMMUNITY PARTICIPATION PROCESS-** Implementation of this plan will require ongoing community outreach efforts to involve more stakeholders, both in the watershed and in the larger communities of Saco and Old Orchard Beach. A sustained public awareness and outreach campaign is essential to secure the long-term community support that will be necessary to successfully implement this project. Much of the success of implementing the recommendations will be contingent on landowner cooperation.
- **DEVELOPING A FIELD MONITORING PROGRAM-** A field monitoring program is necessary to track the anticipated improvements to aquatic health within the Goosefare Brook watershed as restoration actions are implemented. The monitoring program will provide feedback on the effectiveness of restoration practices at the catchment and/or subwatershed level, and

will support optimization of restoration actions through an adaptive management approach. The City of Saco and the Town of Old Orchard Beach with support from DEP will implement and carry out this plan.

- **ESTABLISHING MEASURABLE MILESTONES-** A restoration schedule that includes milestones for measuring the implementation of restoration actions and monitoring activities in the Goosefare Brook watershed is critically important. Once the level of funding has been established to determine the extent of recommended action strategies that can be implemented each year, a detailed schedule featuring iterative implementation and monitoring activities should be developed. Refer to Section 7.3 for more details.

7.2 MONITORING PROGRAM

A well-designed monitoring program is a critical component of the plan since it will establish the relative effectiveness and success of restoration recommendations against pre-implementation (or "baseline") watershed conditions. The current monitoring program should be maintained or improved with two primary goals: monitoring should 1) support the assessment of overall aquatic health of Goosefare Brook over time, and 2) provide an evaluation of the effectiveness of restoration practices for improving the aquatic habitat. Monitoring on Goosefare Brook and its tributaries will be categorized under three water quality topics, 1) Biomonitoring, 2) Chemical Water Quality, and 3) Bacteria.

1. **BIOMONITORING**: Maine DEP will conduct biomonitoring assessments every five years as part of regular program activities. Additional biomonitoring will be conducted as needed downstream of stormwater retrofits and stream corridor and habitat improvements to assess stream response and improvement.
2. **WATER CHEMISTRY**: Trained volunteers and/or municipal staff will conduct annual summer monitoring of DO, temperature, and SpC throughout the watershed to track changes over time in both impaired and high quality areas. Additional areas of concern (e.g., where there was limited data collected during the planning process) may also be monitored to better understand conditions and prioritize actions. This includes the Route 1 North tributary and tidal streams. Monitoring may take place as part of the Maine DEP's Volunteer River Monitoring Program (VRMP), which provides volunteer training, monitoring equipment, and data reporting/analysis.
3. **BACTERIA:** Monitoring for bacteria will be conducted by Maine DEP, MHB, and municipal staff to test for water quality improvements following municipal efforts to remove potential sources. This includes Bear Brook monitoring in 2016 and 2017 following replacement of the sewer line and broken lateral pipe in 2015. MHB will also pursue advanced testing starting in 2016 to determine whether bacteria sources are of human origin.

7.3 MEASURABLE MILESTONES

It is critically important that a watershed restoration project schedule be established that provides clear and measurable milestones for success. These include environmental indicators, which measure response of the stream (Table 14), as well as programmatic indicators, which measure actions taken (Table 15), and social indicators, which measure financial and community support (Table 16). Once funding mechanisms and oversight authority have been established for the Goosefare Brook restoration effort, a more detailed list and schedule of measurable milestones may be developed. Measurable milestones are presented based on three "benchmarks" at 2018, 2021, and 2026 that represent estimated competition by the benchmark date.

- **Environmental Indicators** are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. They assume that BMP recommendations outlined in the Action Plan will be implemented accordingly and will indirectly result in reductions in stream TP concentrations (Table 14).

Table 14. Environmental Indicators for Goosefare Brook

	Benchmarks*		
Indicators	**2021**	**2026**	**2031**
Enhance macroinvertebrate type, abundance, and distribution GOAL: Meet Class B Standards (Based on probabilities of meeting)	5%	50%	100%
Reduction in TP from stormwater GOAL: 420 lbs. reduction in modeled TP	10% of goal	50% of goal	100% of goal
Improvement of the stream channel and corridor through reduced erosion, increased buffers, and necessary channel alterations. GOAL: 72 Sites	20 sites addressed	40 sites addressed (Phase I)	72 sites addressed
Eliminate bacteria sources on Goosefare Brook and Tributaries GOAL: *Geometric means for all sites meet applicable freshwater or estuarine state requirements*	10% of goal	50% of goal	100% of goal

**Benchmarks are cumulative starting at year 1.*

- **Programmatic Indicators** are indirect measures of watershed protection and restoration activities. Rather than indicating that water quality reductions are being met, these programmatic measurements list actions intended to meet the water quality goal (Table 15).

Table 15. Programmatic Indicators for Goosefare Brook.

	Benchmarks*		
Indicators	**2021**	**2026**	**2031**
Amount of funding secured for plan implementation (include contributions from fundraisers, donations, and grants)	$700,000	$1,400,000	$2,100,000
Number of areas installed with structural BMPs	10	25	52
Number of non-structural restoration activities completed	5	10	15
Number of parcels with new conservation easements	1	3	5
Number of copies of watershed-based educational materials distributed	150	300	600

**Benchmarks are cumulative starting at year 1.*

- **Social Indicators** measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvement (Table 16).

Table 16. Social Indicators for Goosefare Brook.

	Benchmarks*		
Indicators	**2021**	**2026**	**2031**
Number of volunteers participating in educational campaigns	50	100	150
Number of people participating in workshops or demonstrations	20	50	75
Number of newly trained MHB volunteers (partner with MHB)	2	4	6
Percentage of residents making voluntary upgrades or maintenance to their septic systems (with or without free technical assistance), particularly those identified as needing upgrades or maintenance	10%	25%	50%

**Benchmarks are cumulative starting at year 1.*

8 REFERENCES

Allan, J. D. and M. M. Castillo. 2007. Stream ecology: structure and function of running waters. 2nd ed., Springer, Dordrecht, Netherlands. 436 pp.

Brungs, W.S. and B.R. Jones. 1977. Temperature Criteria for Freshwater Fish: Protocols and Procedures. EPA-600/3-77-061. Environ. Research Lab, Ecological Resources Service, U.S. Environmental Protection Agency, Office of Research and Development, Duluth, MN.

City of Saco, 2011, City of Saco Comprehensive Plan, Appendix L: Land Use.

Center for Watershed Protection (CWP). 2003. Impacts of IC on Aquatic Systems. Retrieved from http://clear.uconn.edu/projects/tmdl/library/papers/Schueler_2003.pdf

EPA, 2008, "Handbook for Developing Watershed Plans to Restore and Protect Our Waters". EPA 841-B-08-002. March 2008. http://www.epa.gov/owow/nps/watershed_handbook. Accessed online on November 5, 2014.

FBE 2011. Whitten Brook Watershed Restoration Plan. FB Environmental Associates. March 2011.

Field, John. Fluvial Geomorphic Assessment of Goosefare Brook in Saco, Maine. October 2015.

Goosefare Brook Watershed Survey, 2002.

Law, N.L., K. DiBlasi, and U. Ghosh. 2008. Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping and Storm Drain Cleanout Programs in the Chesapeake Bay Basin. Center for Watershed Protection. Prepared for U.S. EPA Chesapeake Bay Program Grant CB-973222-01: Ellicott City, MD. www.cwp.org.

Long Creek Annual Monitoring Report June 2010 through November 2011 (February 2012), Long Creek Watershed Management District.

Maine Department of Conservation (MDC) and Maine Geological Survey (MGS), 1999, GISVIEW.MEGIS.Surf. Accessed: February 2016.

Maine DEP, 2003, Goosefare Brook TMDL: Final Report. http://www.maine.gov/dep/water/monitoring/tmdl/2003/tmdlgoosefarereport.pdf

Maine DEP. 2011, Maine DEP Biomonitoring. http://www.maine.gov/dep/water/monitoring/biomonitoring/materials/finlmeth1.pdf. Accessed online on July 1, 2014.

Maine DEP. 2012. Integrated Water Quality Monitoring and Assessment Report. DEPLW-1246. 219 p. http://www.maine.gov/dep/water/monitoring/305b/2012/report-final.pdf

Maine DEP. 2012b. Maine Impervious Cover Total Maximum Daily Load Assessment. Appendix 12. TMDL Assessment Summary – Goosefare Brook.

Maine DEP. Maine Statewide Bacterial TMDL: Freshwater Addendum. Report DEPLW-1254. August 2014. http://www.maine.gov/dep/water/monitoring/tmdl/2014-statewide-bacteria-tmdl-addendum/Appendix_B_Goosefare_Brook.pdf

Maine DEP. Surface Water Ambient Toxics (SWAT) Monitoring Program 2015 Report (Draft).

Maryland Department of Natural Resources. Stream Corridor Assessment Survey. September 2001.

Maine Healthy Beaches. April 2015. Maine Healthy Beaches 2014 Report to US EPA. http://www.mainehealthybeaches.org/documents/MHB%202014%20US%20EPA%20Report.pdf

MEGIS, 2006, Maine Office of GIS Data Catalog United States Land Cover. http://www.maine.gov/megis/catalog/metadata/melcd.html

Meyer, Judy L., Kaplan, L.A, Newbold, D., Strayer, D.L., Woltemade, C.J., Zedler, J.B., Beilfuss, R., Carpenter, Q., Semlitsch, R., Watzin, M.C., Zedler, P.H. Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands. February 2007. http://www.americanrivers.org/assets/pdfs/reports-and-publications/WhereRiversAreBorn1d811.pdf

Muskie School of Public Service, 2012, Changing Maine – Maine's Changing Population and Housing 1990-2010. A Report of the Sustainable Urban Regions Project – Maine Sustainability Solutions Initiative. University of Southern Maine. September 2012. Retrieved Online: http://umaine.edu/mitchellcenter/files/2013/08/Census_Report_1012121.pdf

Natural Resources Conservation Service (NRCS), United States Department of Agriculture, 2013, Official Soil Series Descriptions [Online WWW]. Available URL: "http://soils.usda.gov/technical/classification/osd/index.html" [Accessed 08 March 2016]. USDA-NRCS, Lincoln, NE.

OOB, 2013, Old Orchard Beach Comprehensive Plan, contact: http://www.oobmaine.com/pages/oldorchardbeachme_plandept/index

UNHSC. 2011. University of New Hampshire Stormwater Center. Examination of Thermal Impacts from Stormwater Best Management Practices. January 2011.

US Census Bureau American Fact Finder. Fact Sheet DP-1, accessed February 2016, Profile of General Population and Housing Characteristics, 2010, http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

CH2MHill, 2015. Summary of Literature-Derived Fish Tissue Toxicity Data for the Baseline Ecological Risk Assessment Halaco Superfund Site, Oxnard, California Remedial Investigation. Prepared for USEPA Region 9 by CH2MHILL, 325 East Hillcrest Drive, Suite 125, Thousand Oaks, California 91360

Stanfield and Kilgour. 2006. Effects of Percent Impervious Cover on Fish and Benthos Assemblages and In-stream Habitats in Lake Ontario Tributaries. American Fisheries Society Symposium 48:577-599.

Wenger, S. et al. 2008. Stream fish occurrence in response to impervious cover, historic land use, and hydrogeomorphic factors. Can. J. Fish Aquatic Sci. 65 1250-1264.