Hampton-Seabrook Estuary Management Plan

FOR THE SEABROOK-HAMPTONS ESTUARY ALLIANCE

FB ENVIRONMENTAL ASSOCIATES
DOVER, NH

FINAL | March 2023

SEABROOK-HAMPTONS ESTUARY ALLIANCE

24 Stickney Terrace, Unit 2
Hampton, NH 03842
info@shea4nh.org

FB ENVIRONMENTAL ASSOCIATES

383 Central Avenue, Suite 267
Dover, NH 03820
info@fbenvironmental.com
(207) 221-6699
www.fbenvironmental.com

This project was supported by the NH State Conservation Committee Conservation Moose Plate Grant Program. Additional funding was provided by the Piscataqua Region Estuaries Partnership and the New Hampshire Department of Environmental Services Coastal Program.

Cover Photo: Marinas.com

Acknowledgements

Seabrook-Hamptons Estuary Alliance (SHEA)

Rayann Dionne, Executive Director/Project Lead
Jay Diener, President
Deborah Wrobel, Vice President
Shawn Hanson, Secretary, Treasurer
Rebecca Irelan, Board of Directors
Matthew Cranney, Board of Directors

Plan Advisory Committee

Rayann Dionne, Executive Director/Project Lead, SHEA
Jay Diener, President, SHEA
Steve Couture, Coastal Program Administrator, NHDES Coastal Program
Kevin Lucey, Restoration Coordinator, NHDES Coastal Program
Nathalie DiGeronimo, Resilience Project Manager, NHDES Coastal Program
Chris Nash, Program Manager, NHDES Shellfish Program
Trevor Mattera, Habitat Program Manager, PREP
Cheri Patterson, Marine Fisheries Division Chief, NH Fish and Game
Chris Meaney, Gulf of Maine Coastal Program Project Leader & Field Office Supervisor, US Fish & Wildlife
Gregg Moore, Associate Professor of Biological Sciences, UNH/NH Sea Grant
Alyson Eberhardt, Coastal Ecosystems Specialist, UNH/NH Sea Grant
Pamela Hunt, Avian Specialist, NH Audubon
Jason Bachand, Town Planner, Town of Hampton
Tom Morgan, Town Planner, Town of Seabrook
Paul Geoghegan, Senior Principal Scientist, Normandeau Associates

Technical Staff

Forrest Bell, CEO/Owner, FB Environmental Associates
Laura Diemer, Project Manager & Environmental Monitoring Lead, FB Environmental Associates
Cayce Dalton, Project Manager, FB Environmental Associates
Sarah Large, Project Manager & Wetland Scientist & Permitting Lead, FB Environmental Associates
Luke Frankel, Project Manager, FB Environmental Associates
Bina Skordas, Project Manager, FB Environmental Associates

Table of Contents

Executive Summary

Critical Value

Spanning the towns of Hampton, Hampton Falls, and Seabrook in New Hampshire and the Town of Salisbury in Massachusetts, the **Hampton-Seabrook Estuary is a vast ecological system** composed of salt marsh, sand dunes, beaches, tidal waters, and brackish streams, all of which ultimately drain to the Atlantic Ocean through Hampton Harbor. As **one of two estuaries of national significance** in New Hampshire, the Hampton-Seabrook Estuary is the second largest estuary with the largest continuous area of salt marsh in New Hampshire and contains the last remaining sand dunes and most productive clam flats in the state. The estuary is a pivotal connector that provides habitat continuity between the Gulf of Maine and the Great Marsh to the south in Massachusetts and thus supports critical roosting, feeding, and nesting grounds for shorebirds and salt marsh sparrows. The towns of Hampton, Hampton Falls, and Seabrook **depend on the estuary for tourism, commercial and recreational fishing, recreational shellfishing, aquaculture, and critical ecosystem services** such as flood protection and carbon sequestration.

Issues & Threats

The estuary has been significantly altered from human activities over time. These alterations have made the estuary **less resilient and less capable of performing important ecosystem functions and services** that benefit both humans and wildlife. Because of these alterations, the following habitat and wildlife impacts have been documented:

- **Dune habitat** in the watershed has declined by nearly 84% due to fill and development.
- **Salt marsh area** in the watershed has declined by 614 acres due to tidal restrictions, invasive species colonization, fill, and ditch excavation.
- **Shorebird roosting** has decreased within the estuary due to increased disturbance from construction, rising waters, and more frequent flooding.
- **River herring** in the Taylor River and small fish in the estuary at-large have decreased dramatically despite rebounding in Great Bay.
- **Clam populations** have declined in the estuary since 1997.

These alterations and their impacts stem from activities surrounding human **development**. The land immediately surrounding the estuary and salt marsh is highly developed with residences, commercial businesses, roads, and other impervious surfaces. The 2018 *State of Our Estuaries Report* identified **increasing impervious cover** as a significant pressure indicator for the Hampton-Seabrook Estuary watershed. Dense residential and commercial development, particularly centered around Seabrook Beach, Hampton Beach, and the U.S. Route 1 corridor, has fragmented or **replaced critical wildlife habitat**, **generated stormwater runoff** that conveys pollutants from impervious surfaces to the estuary, and **constrained natural salt marsh migration** in response to sea level rise. Direct human impacts to the estuary and salt marsh have included historic ditching, dredging, and tidal restrictions, in addition to indirect human impacts from climate change, such as sea level rise and changes in precipitation patterns and air temperature. The combination of coastal inundation from sea level and groundwater rise and storm surges following large precipitation events are putting **communities and infrastructure at great risk due to more frequent, intense, and prolonged flooding.** Hampton alone accounts for 42% of flood-related losses and damages in the last 32 years within Rockingham County and 20% of the losses statewide.

Other threats to the estuary include wastewater from malfunctioning septic systems or leaky sewer lines; soil erosion from construction activities, unpaved roads and trails, or banks; residential or commercial fertilizer and pesticide use; hazardous waste; agricultural practices; pet waste; nuisance wildlife such as large congregations of waterfowl or seagulls attracted by human-related activities; and invasive species.

The Hampton-Seabrook Estuary is at **continued risk because of new development** and increasing human population in the watershed, which will be **compounded by the stress imposed by ongoing climate change**. Impacts to infrastructure and critical facilities from enhanced flooding will come at a high economic and environmental price unless resiliency techniques are implemented. For example, it is expected that more salt marsh will be lost in the future from sea level rise. The continued loss of salt marsh will increase local flood risk and reduce critical habitat for a variety of wildlife.

Purpose & Scope

The **Hampton-Seabrook Estuary Management Plan (EMP)** uses science, data, and policies on current and future threats, conditions, and uses of the estuary to formulate effective management strategies that can be implemented by the communities of Hampton, Hampton Falls, and Seabrook and numerous other partners and stakeholders. The EMP **serves as a roadmap** for the collaborative management of the estuary across stakeholder groups, regardless of political boundaries. The hope is that the EMP incorporates an understanding of the estuary's stressors and **provides a holistic management approach** for the communities to achieve their shared vision.

We set the EMP for **10 years as a manageable time span** to coordinate and carry out the recommended strategies and actions. Beyond 10 years, there are usually new technologies, new funding sources, new data, new partners, and new understanding related to the estuary that should be re-evaluated and updated to keep this document relevant.

Key Partners

Numerous partners and stakeholders, including **SHEA**, have been involved with research, monitoring, planning, and management of the Hampton-Seabrook Estuary over the years. Key partners include the National Oceanic and Atmospheric Administration (**NOAA**), the U.S. Environmental Protection Agency (**EPA**), **New Hampshire Sea Grant**, New Hampshire Department of Environmental Services (**NHDES**), New Hampshire Fish and Game (**NHFG**), Great Bay National Estuarine Research Reserve (**GBNERR**), University of New Hampshire (**UNH**), **UNH Cooperative Extension**, New Hampshire Coastal Adaptation Workgroup (CAW**),** Piscataqua Region Estuaries Partnership (**PREP**), and Rockingham Planning Commission (**RPC**). Additional stakeholders include the **U.S. Army Corps of Engineers**, U.S. Fish and Wildlife Service (**USFWS**), New Hampshire **Audubon**, Northeastern Regional Association of Coastal Ocean Observing Systems (**NERACOOS**), The Nature Conservancy (**TNC**), and Rockingham County Conservation District (**RCCD**). With the help of partners, SHEA has led the establishment of **Flood Smart Roundtables** and important groups such as Hampton's Coastal Hazards Adaptation Team (**CHAT**), Seabrook's Coastal Resilience Team (**CRT**), and the Hampton-Seabrook Estuary Collaborative (**HSEC**).

Community Involvement & Input

Development of the EMP began with research and monitoring studies of the estuary that have contributed to our foundational knowledge of the ecological structure, function, and value of the Hampton-Seabrook Estuary. Other studies have provided additional assessment findings and management recommendations over the years.

As part of the preliminary EMP development stage, several major projects were undertaken by SHEA: (1) an **audit** of existing land use planning and municipal input in 2020; and (2) a public **visioning survey** in 2021; and (3) a **partner survey**, three working **webinars** on salt marshes, and development of a ***Prospectus*** from 2020-2022 to better understand the existing science and needs of the estuary, in conjunction with the HSEC.

During the active EMP development stage, these documents and more (such as regional reports) were reviewed and integrated into the EMP by FB Environmental Associates (FBE) to provide a holistic overview of research, monitoring, planning, and management work in the Hampton-Seabrook Estuary watershed. Development of the EMP was also guided by review and input from a **Technical Advisory Committee**, whose members represented the following stakeholders: SHEA, NHDES Coastal Program, NHDES Shellfish Program, PREP, NHFG, USFWS, New Hampshire Sea Grant, New Hampshire Audubon, RCCD, towns of Hampton, Hampton Falls, and Seabrook, and Normandeau Associates (see Acknowledgements). As a continuation of the municipal and public outreach efforts by SHEA, FBE completed **interviews** in 2022 with eight different municipal officials or employees and private sector professionals. SHEA conducted additional **listening sessions with Winnacunnet High School biology students** in 2022 to better capture the interests and concerns of younger generations in the vision statement and goals of the EMP. Finally, SHEA **presented draft chapters and solicited feedback** from selectboards, planning boards, conservation commissions, and other municipal groups in each of the three towns in fall 2022.

Stakeholder engagement, much of which has been led by SHEA, has been one of the most critical components to the successful development of the EMP and will continue to be one of the most critical components to the successful implementation and execution of the EMP.

The Vision

The Hampton-Seabrook Estuary is a thriving and resilient estuarine environment, home to healthy, diverse populations of fish, shellfish, birds, plants, and other native species and sustainably used by surrounding communities for its aesthetic, recreational, and economic benefits and ecosystem services. Local governments, residents, and visitors recognize, respect, and enjoy the watershed's connective habitats, litter-free beaches, and clean waters which form the bedrock of their community. Development occurs in a manner that protects both natural resources and infrastructure and allows the estuary and its watershed to naturally adapt to the effects of climate change, including, but not limited to, groundwater and sea level rise, coastal storm surges, and flooding.

Goals & Objectives

Five goals are presented in this EMP, each encompassing several objectives. Each of the five goals is a topical theme derived from the vision statement for the estuary. Objectives identified for each goal provide specific targets to fulfill each goal. Some objectives are relevant to multiple goals but are only shown once under the most applicable goal. For example, Goal 2 objectives offer natural strategies to combat flooding, while Goal 5 objectives offer strategies related to municipal land use planning and equity principles that also address flooding or the environmental justice impacts from flooding. Subsequent sections of this EMP identify strategies or specific actions to achieve each objective, along with criteria to evaluate the successful execution of each strategy or action item.

Management Strategies

With historic and current human activities threatening the estuary and surrounding landscape, implementation of robust management strategies will be needed to maintain and/or restore the estuary's ecological services, most especially in the face of climate change impacts to communities and wildlife in the area. Strategies outlined in this EMP include stormwater management and pollutant reduction measures, flood response, shoreline stabilization, land conservation, local planning and regulations, harbor operations and navigation, shellfish management, wildlife habitat protection, environmental justice, and public access.

High priority actions that the Technical Advisory Committee identified as needing to be addressed in the near-term include the following (refer to Appendix B for the complete list of actions):

- **Stormwater and other pollutant reduction management measures**: require low impact development techniques; enhance buffers; optimize Municipal Separate Storm Sewer System (MS4) compliance; enforce septic system regulations.
- **Salt marsh resiliency and flood response**: stabilize banks through living shorelines; conserve and/or restore natural buffer and migration areas; remediate ditching; replace restrictive tidal crossings.
- **Local planning and regulations**: adopt the Hampton-Seabrook EMP into each town's Master Plan; implement coastal resilience report recommendations; limit development in Conservation Focus Areas (CFAs); develop liaison programs for community-based organizations to participate in hazard mitigation and climate resilience planning; enhance emergency access and evacuation routes; provide affordable, resilient housing; require hazard zone disclosure information be provided to new homebuyers and renters.
- **Shellfish management**: continue to fund the NH Shellfish Program; continue to document rain-driven water quality impacts on shellfish growing areas.
- **Improve wildlife habitat**: remove barriers to fish passage.
- **Harbor navigation**: use beach profiling data to inform where dredge materials may be most beneficial.
- **Research and networking**: coordinate a water level gauging network for the Hampton-Seabrook Estuary; evaluate six existing Surface Elevation Tables (SETs) on a bi-annual cycle; coordinate with other stakeholders to build a sense of shared ownership; initiate long-term

vegetation monitoring in the salt marsh; develop a sediment budget for the estuary; investigate the effects of tidal crossings and their replacements on salt marsh health; conduct an assessment of the economic impacts from sea level rise; complete assessment of nutrients, sediment, seagrasses, fish, and oysters to determine co-variability in health.

- **Outreach and community engagement**: enhance public access and recreational engagement safely and equitably; install informational kiosks at viewpoints; convene clean-up days; offer field trips; distribute information on coastal resiliency through a variety of formats; engage with community-based organizations and youth groups.

The recommendations of **this plan will be led largely by SHEA** with assistance from a diverse stakeholder group, including representatives from the towns (e.g., select boards, planning boards, and conservation commissions), state and federal agencies or organizations, nonprofits, land trusts, schools and community groups, local business leaders, and landowners.

The **cost of successfully implementing the plan is highly variable** depending on numerous factors. This financial investment can be accomplished through a variety of funding mechanisms via both state and federal grants, as well as commitments from municipalities or donations from private residents. SHEA and the HSEC plan to work collectively and diligently to support and assist the communities in identifying and securing grants to support the implementation of EMP action items. Of significant note, this plan meets the nine planning elements required by the EPA for an alternative watershed-based plan, and **eligible entities within the watershed are now eligible for federal watershed assistance grants.**

A Note for Municipalities

Municipalities are oftentimes strained to meet the high financial obligations of addressing a multitude of issues important to their communities, with the actions in this EMP representing only a fraction of the issues that municipalities are compelled to address. With that understanding, municipalities are not alone in shouldering the costs of implementing this EMP. In fact, it is expected that SHEA and the HSEC will be able to assist in finding opportunities to financially support the actions of this EMP through numerous grants (see Funding Opportunities). The Action Plan (Appendix B) identifies municipalities as primary or secondary responsible parties for most of the actions because most actions cannot be completed without municipal support or action. It is the hope that this EMP will serve as a jumping off point for building an even stronger and more cohesive watershed-wide stakeholder team that works together to achieve the goals and objectives of this EMP.

Important Notes

Climate change disproportionately affects the most vulnerable people within a community, including the elderly, disabled, and impoverished, and the watershed communities of the Hampton-Seabrook Estuary are no exception. Acknowledging and considering community demographics and their vulnerabilities in climate change adaptation planning at the local, state, and federal levels are critical to protecting all people within a given watershed. Environmental issues often co-occur with economic and social issues, and municipalities need to be prepared to address multiple issues at once. Whether it is choosing which structures to protect or assisting in relocation efforts, it is essential that municipalities make decisions and allocate resources in an equitable manner that takes into consideration the needs of its most vulnerable residents. **Considering environmental justice principles in municipal planning is still in its infancy and much**

work is being done to advance our understanding of what it means and how it can be best incorporated into planning.

The **success of this plan is dependent on the continued effort of volunteers and a strong and diverse stakeholder group** (such as the HSEC) that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim milestones. **Achieving the vision for the estuary is no easy task**, and because there are many diffuse sources of pollutants reaching the estuary from existing development, roads, septic systems, and other land uses in the watershed, along with myriad other threats to the estuary's resiliency, it **will require an integrated and adaptive approach across many different parts of the watershed community to be successful.**

A Note for Municipalities

Municipal engagement is a critical piece in the successful implementation of this plan. With SHEA's support and guidance in identifying and prioritizing actions and funding opportunities, each town can use this plan to align their community's vision and planning activities with the goals and actions specified herein. The first step that each town can take is to adopt this plan as an addendum to their master plan. The second step is for each town to send one or more representatives to meetings of groups such as CHAT and the HSEC. The third step is for town staff to have at least annual meetings with SHEA to review the status of action items relevant to the town. SHEA plans to give regular presentations to the town boards to keep Hampton-Seabrook Estuary top-of-mind.

Introduction

Estuary Location & Description

Spanning the towns of Hampton, Hampton Falls, and Seabrook in New Hampshire and the Town of Salisbury in Massachusetts, **the Hampton-Seabrook Estuary is a vast ecological system composed of salt marsh, sand dunes, beaches, tidal waters, and brackish streams**, all of which ultimately discharge to the Atlantic Ocean through Hampton Harbor (Figures 1 and 2). The 45.5-square-mile estuary watershed also extends into portions of the New Hampshire towns of Kensington, Exeter, Stratham, and North Hampton (Figure 2). About 82% of the watershed resides within New Hampshire, with the remaining 18% in Massachusetts (Figure 2).

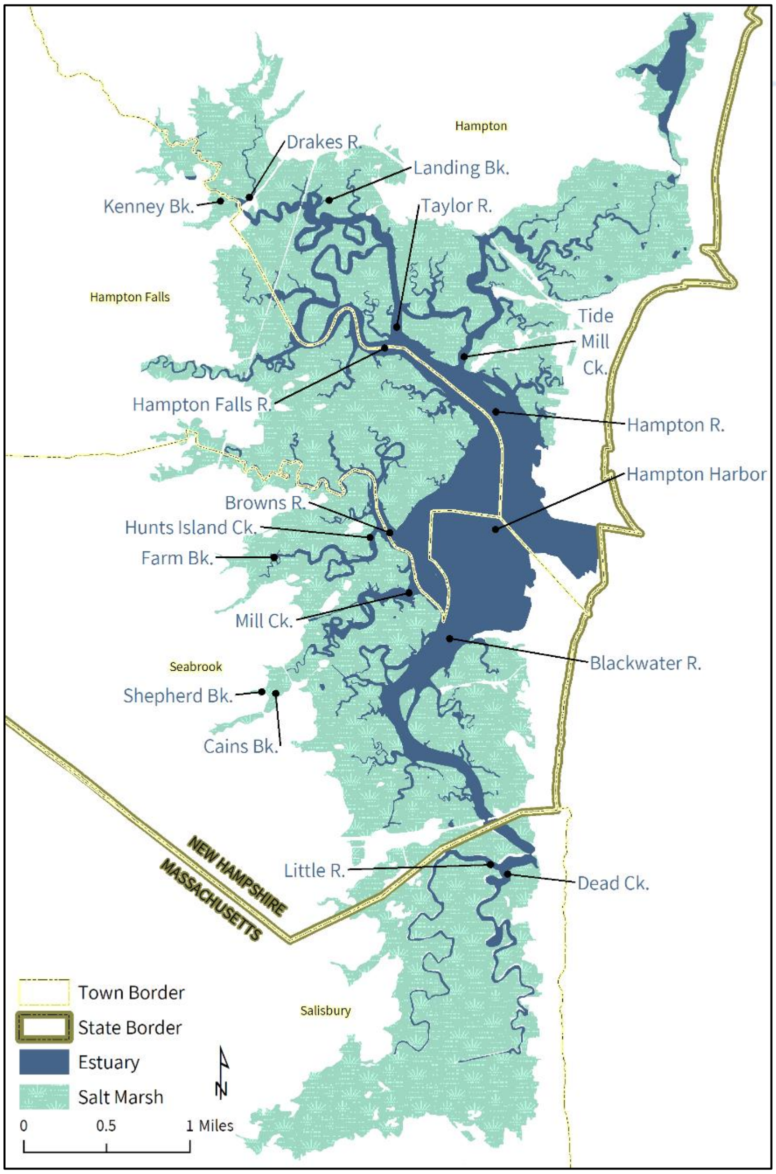


Figure 1. *Hampton-Seabrook Estuary showing open water and salt marsh areas within town and state boundaries.*

As the **second largest estuary in New Hampshire**, the 1,470-acre estuary (see blue area in Figure 1) is a tidally dominated, barrier beach system that is surrounded by expansive salt marsh (see green area in Figure 1) (Jones, 2000; Eberhardt & Burdick, 2008). At high tide, the main, open water portion of the estuary is 475 acres with 72 miles of tidal shoreline (PREP, 2015). The **salt marsh surrounding the estuary is the largest continuous area of salt marsh in New Hampshire,** covering approximately 4,570 acres, 32% (1,463 acres) of which is within Hampton, NH, 27% (1,240 acres) within Seabrook, NH, 23% (1,071 acres) within Salisbury, MA, and the remaining 18% (797 acres) within Hampton Falls, NH (Figure 1). The estuary, which includes the Hampton River, is fed by six freshwater and tidal tributary river systems: Taylor and Drakes rivers, Hampton Falls River, Browns River and Hunts Island Creek, Cains Brook and Mill Creek, Blackwater and Little Rivers, and Tide Mill Creek (Jalbert Leonard, Dionne, Lucey, Mattera, & Meaney, 2021) (Figure 1). The confluence of the Hampton Falls and Taylor Rivers creates the Hampton River which broadens into Hampton Harbor. The lower reaches of the tributary river systems become brackish from tidal influence as they approach Hampton Harbor.

Tides within the estuary are semi-diurnal and regulated through the dredged Hampton Harbor inlet, with a mean tidal range of 9.0 feet (SLR, 2021). At mean low tide, water depth is roughly 20 feet at the harbor entrance and less than 3 feet within the tidal creeks and rivers (Jones, 2000). The Hampton-Seabrook Estuary is generally well-mixed due to shallow water depths and relatively little freshwater input. Thus, thermal stratification is rarely observed in the estuary; however, temporary density-driven stratification can form during heavy rainfall events. Salinity in the estuary is dependent on freshwater input from the watershed and is usually lowest in the spring and highest in the summer and early fall. Greater streamflow in the spring is caused by snowmelt, heavy rainfall, and low evapotranspiration, while reduced streamflow in the summer and early fall is caused by light rainfall and high rates of evapotranspiration (Nash & Dejadon, 2019).

The Hampton-Seabrook Estuary is one of two estuaries of national significance in New Hampshire, with the other being the Great Bay Estuary. The main differences between the Hampton-Seabrook and Great Bay estuaries are in both geomorphology and biota as the Hampton-Seabrook Estuary contains sand dunes that support a variety of unique flora and fauna (Jalbert Leonard, Dionne, Lucey, Mattera, & Meaney, 2021). Regionally, **the Hampton-Seabrook Estuary is a pivotal connector that provides habitat continuity between the Gulf of Maine and the Great Marsh to the south in Massachusetts**. The diverse coastal habitats that the estuary provides are home to softshell clams, saltmarsh sparrows, piping plovers, diadromous fish populations, and many rare, threatened, and endangered species. As one of the most productive ecosystems, the expansive salt marshes of the Hampton-Seabrook Estuary consist of a variety of species of salt-tolerant grasses and vegetation that provide valuable habitat to wildlife. **The estuary also contains "the last remaining sand dunes in coastal New Hampshire and the most productive clam flats in the state"** (PREP, 2015; Jalbert Leonard, Dionne, Lucey, Mattera, & Meaney, 2021), **and supports critical "roosting, feeding, and nesting grounds for shorebirds and salt marsh sparrows"** (Eberhardt & Burdick, 2008). The estuary's rich marine life – from plankton to invertebrates to fish – generates important recreational and commercial opportunities for coastal New Hampshire. Finally, the estuary and supporting salt marsh provide a multitude of other ecosystem services that are critical to humans, including, but not limited to, **protection from flooding and storm surges and carbon sequestration.**

Seabrook, NH salt marsh. Photo Credit: Brian Whitney.

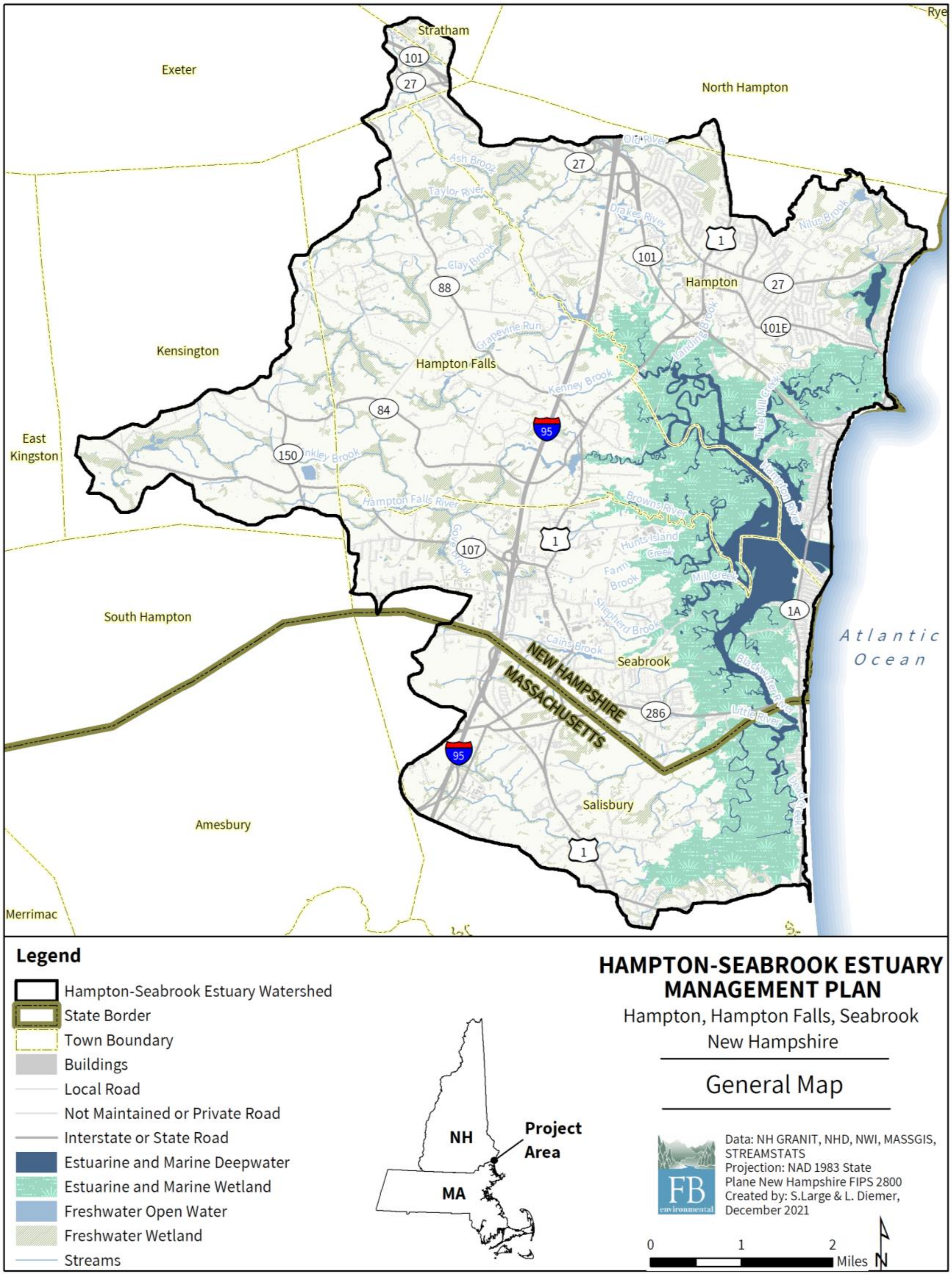


Figure 2. *General map of the Hampton-Seabrook Estuary watershed.*

Purpose & Scope

The Hampton-Seabrook Estuary Management Plan (EMP) uses science, data, and policies on current and future threats, conditions, and uses of the estuary to formulate effective management strategies that can be implemented by the communities of Hampton, Hampton Falls, and Seabrook and numerous other partners and stakeholders. Implementing these management strategies will achieve the vision for the estuary, which stakeholders identified as being a sustainable, healthy, and resilient environment providing ecosystem services for the benefit of communities and wildlife.

The impetus for developing the EMP was to streamline all previous and ongoing efforts related to the estuary into a single guiding document for more effective stakeholder collaboration. **The EMP serves as a roadmap for the collaborative management of the estuary across stakeholder groups**, regardless of political boundaries. Municipalities can adopt all or a portion of the EMP as a companion document to their individual master plans so that each town's vision aligns with the collective vision for the estuary. Stakeholders can use the EMP to prioritize planning and support funding opportunities for implementation of the recommended management strategies in the action plan. Seabrook-Hamptons Estuary Alliance (SHEA) will treat the EMP as a vibrant working document to be updated on a regular basis (every 5-10 years) so that the management goals, objectives, and actions are evaluated against expected milestones and timeframes and adjusted accordingly to adapt to any changes in the threats, conditions, and uses of the estuary over time. The hope is that the EMP incorporates an understanding of the estuary's stressors and **provides a holistic management approach for the communities to achieve their shared vision.**

Project Partners

Numerous partners and stakeholders, including **SHEA**, have been involved with research, monitoring, planning, and management of the Hampton-Seabrook Estuary over the years. Formed in 2013 by a group of concerned residents, SHEA is a nonprofit, community-based organization "established for the protection of coastal and aquatic resources and the preservation of the Seabrook-Hamptons estuarine system through education, community outreach, and research" (SHEA, 2022a). Key partners include the National Oceanic and Atmospheric Administration (**NOAA**), the U.S. Environmental Protection Agency (**EPA**), **New Hampshire Sea Grant**, New Hampshire Department of Environmental Services (**NHDES**), New Hampshire Fish and Game (**NHFG**), Great Bay National Estuarine Research Reserve (**GBNERR**), University of New Hampshire (**UNH**), **UNH Cooperative Extension**, New Hampshire Coastal Adaptation Workgroup (**CAW**), Piscataqua Region Estuaries Partnership (**PREP**), and Rockingham Planning Commission (**RPC**). Additional stakeholders include the **U.S. Army Corps of Engineers**, U.S. Fish and Wildlife Service (**USFWS**), New Hampshire **Audubon**, Northeastern Regional Association of Coastal Ocean Observing Systems (**NERACOOS**), The Nature Conservancy (**TNC**), and Rockingham County Conservation District (**RCCD**).

Beginning in 2019, following a series of three successful "Building a Flood Smart Seacoast" workshops in 2018, SHEA has held **Flood Smart Roundtables**, informal discussion-based meetings open to seacoast New Hampshire residents and property owners who want to learn more about flooding issues and mitigation opportunities. SHEA invites guest speakers to present on key topics of interest such as the June 9, 2022 webinar on the National Flood Insurance Program (NFIP). SHEA also launched in 2022 a new section of their website featuring student-based research related to the Hampton-Seabrook Estuary.

Establishing the **Coastal Hazards Adaptation Team (CHAT)** in 2019, SHEA and the NHDES Coastal Program teamed up with the Town of Hampton on a "long-term planning process to research and guide coastal adaptation strategies to cope with coastal flooding from high tides, storm surges, and sea level rise" (SHEA, 2022b). Representatives from the Town of Hampton have included members of the Hampton Board of Selectmen, Planning Board, Zoning Board of Adjustment, Department of Public Works, Hampton Beach Village District, Hampton Beach Area Commission, as well as the Hampton Town Planner, Hampton Conservation Coordinator, and three representative residents from different neighborhoods impacted by rising tides and storm surges. At the time of this publication, CHAT continues to meet monthly to support the implementation of its recommendations related to flooding, coastal hazards, and coastal planning.

Formed in 2020 and led by PREP, EPA, and SHEA, with assistance from Roca Communications, the **Hampton-Seabrook Estuary Collaborative (HSEC)** is a group of local, state, and federal organizations focused on aligning resources and activities to improve the long-term health and vitality of the Hampton-Seabrook Estuary and its communities (PREP, 2022). The HSEC's steering committee includes representatives from the USFWS, NHDES Coastal Program, Great Bay NERR, NOAA, U.S. Army Corps of Engineers, National Fish and Wildlife Foundation (NFWF), UNH, New Hampshire Sea Grant, New Hampshire Audubon, NERACOOS, Atlantic Coast Joint Venture, and local government commissions. With funding from NOAA and USFWS, SHEA hired EF Design & Planning, LLC to serve as an Interim Collaborative Coordinator (ICC) for at least eight months from August 2022-April 2023. The ICC facilitates HSEC meetings, identifies funding opportunities, and provides grant support.

Community Involvement & Planning

Development of the EMP began with research and monitoring studies of the estuary that have contributed to our foundational knowledge of the ecological structure, function, and value of the Hampton-Seabrook Estuary. Other studies have provided additional assessment findings and management recommendations over the years. In 2006, **a watershed management plan was developed for the Cains Brook and Mill Creek subwatershed area** of the estuary and included recommended management actions for a portion of the Hampton-Seabrook Estuary watershed (Waterfront Engineers, Inc, 2006). In 2008, comprehensive restoration strategies for the estuary's habitats were developed as part of a **compendium document** (Eberhardt & Burdick, 2008). In 2015, PREP completed the **Piscataqua Region Environmental Planning Assessment (PREPA)** for the Hampton-Seabrook Estuary watershed, including Hampton, Hampton Falls, and Seabrook, which provided priority recommendations in a "report card" format for strengthening municipal natural resource protection regulations (PREP, 2015). In 2019, NHDES completed a **sanitary survey of Hampton Harbor**, which included an in-depth review of potential pollutant sources to the estuary (Nash & Dejadon, 2019).

In 2019, CHAT completed a ***Situation Assessment*** to better understand flooding impacts, costs, concerns, and experiences in Hampton (EF Design & Planning, LLC, 2019), as well as a ***2019 CHAT Review*** that provides a summary of CHAT processes and procedures, mapping, resources, and research findings related to coastal flooding in Hampton (SHEA & NHDES Coastal Program, 2020). By December 2020, CHAT prepared and presented draft recommendations for the Town of Hampton to best adapt to or mitigate impacts from sea level rise, tidal flooding, and storm surge activity (SHEA, 2022b). In 2021, the Town of Hampton updated their ***Coastal Resilience Report*** (SLR, 2021) in time for a complete update of their

Master Plan, which is still pending at the time of this EMP publication (Town of Hampton, NH, 2021; Town of Hampton, NH, 2023).

From 2020-2022, HSEC distributed a **survey** to partners, held three working webinars, and developed a ***Prospectus*** (Jalbert Leonard, Dionne, Lucey, Mattera, & Meaney, 2021) to better understand the existing science and needs of the estuary. Survey respondents indicated significant data needs for better understanding all four topic areas (salt marshes, water quality, fish and wildlife, and water level data), but salt marshes stood out as the top priority data need. Three working webinars were held to better understand salt marsh science, monitoring, and management. Information gained from the survey, HSEC meetings, and webinars were summarized in the *Prospectus*. In addition, an online tool called **"The Commons"** was created to help partners easily identify projects, resources, and potential partners for science and monitoring collaborations in the Hampton-Seabrook Estuary (PREP, 2022). In 2022, a **5-page summary document** was created by the USFWS and NOAA, with input and assistance by the HSEC, to highlight ongoing work and opportunities for additional investment in the Hampton-Seabrook Estuary watershed; the document has been used as a communication tool when speaking with potential funders (Meaney, 2022).

As part of the preliminary EMP development stage, two major projects were undertaken by SHEA: (1) an **audit of existing land use planning and municipal input** in 2020; and (2) a **public visioning survey** in 2021. For the audit, SHEA hired EF Design & Planning, LLC to complete a review of municipal planning documents and ordinances related to land use development and natural resource protection in the towns of Hampton, Hampton Falls, and Seabrook. This assessment of current municipal estuary management and planning efforts, along with input from municipal staff and boards, identified the need for a single guiding document for protecting and managing the estuary and helped inform the EMP's management strategies. For the public visioning survey, SHEA, with assistance from the Farrell Strategic Group, deployed a 30-question online survey to residents and visitors of Hampton, Hampton Falls, and Seabrook. The results are presented in the *Public Visioning Survey Report* (Farrell Strategic Group, 2021) and summarized in the Vision for the Estuary section. Insights gained from the public survey were used to inform the vision statement.

During the recent EMP development stage, these documents and more (such as regional reports) were reviewed and integrated into the EMP by FB Environmental Associates (FBE) to provide a holistic overview of research, monitoring, planning, and management work in the Hampton-Seabrook Estuary watershed. Development of the EMP was also guided by review and input from a **Technical Advisory Committee**, whose members represented the following stakeholders: SHEA, NHDES Coastal Program, NHDES Shellfish Program, PREP, NHFG, USFWS, New Hampshire Sea Grant, New Hampshire Audubon, RCCD, towns of Hampton, Hampton Falls, and Seabrook, and Normandeau Associates (see Acknowledgements). As a continuation of the municipal and public outreach efforts by SHEA, FBE completed **interviews** in 2022 with eight different municipal officials or employees and private sector professionals. These interviews provided additional community insight into the estuary's threats and values and informed the vision statement (refer to Vision for the Estuary section for a discussion of interview results). SHEA conducted **additional listening sessions with Winnacunnet High School biology students** in 2022 to better capture the interests and concerns of younger generations in the vision statement and goals of the EMP. Finally, SHEA presented draft chapters and **solicited feedback from selectboards, planning boards, conservation commissions, and other municipal groups** in each of the three towns in fall 2022. Stakeholder engagement, much of which has been led by SHEA, has been one of the most critical components to the successful development of the EMP and will continue to be one of the most critical components to the successful implementation and execution of the EMP.

EPA's Nine Planning Elements

EPA guidance lists nine elements that are required within a watershed management plan to restore waters impaired or likely to be impaired by nonpoint source (NPS) pollution and be eligible for federal grant funding. Many of these elements are geared toward achieving single pollutant target reductions in surface waters; however, water quality is only one component of the goals set forth in this EMP. Other goals also include habitat restoration, native wildlife protection, community resiliency, public access, and environmental justice.

The nine required elements found within this plan are as follows:

A. **IDENTIFY CAUSES AND SOURCES OF POLLUTION OR DEGRADATION:** The Current Environmental Conditions and Uses of the Estuary section highlights sources of NPS pollution to the estuary and describes the environmental condition of key natural resources.
B. **ESTIMATE NUMERIC OUTCOMES EXPECTED FROM MANAGEMENT MEASURES:** Quantification of pollutant load and reductions or other metrics expected from management measures were not performed for this plan, which may be acceptable by EPA as an alternative watershed-based plan given the broader goals and objectives set for the estuary.
C. **DESCRIBE MANAGEMENT MEASURES TO ACHIEVE GOALS:** The Management Strategies section and the Action Plan (Appendix B) identify ways to achieve the goals and objectives through general management strategies and the implementation of specific action items.
D. **ESTIMATE TECHNICAL AND FINANCIAL ASSISTANCE NEEDED:** The Action Plan (Appendix B) includes a description of the estimated associated costs, potential sources of funding, and primary authorities for implementation. Sources of funding need to be diverse and should include local, state, and federal granting agencies, local groups, private donations, and landowner contributions.
E. **DEVELOP EDUCATION & OUTREACH PLAN:** The Management Strategies section describes how the educational component of the plan is already being or will be implemented to enhance public awareness of the plan and participation in plan implementation activities.
F. **DEVELOP AN IMPLEMENTATION SCHEDULE:** The Action Plan (Appendix B) provides a list of action items and recommendations. Each item has a schedule that defines when the action can likely begin and/or end or run through (if an ongoing activity). The schedule should be adjusted by SHEA on an annual basis (see the section on Adaptive Management).
G. **DESCRIBE INTERIM MEASURABLE MILESTONES:** The Plan Implementation & Evaluation section outlines indicators and milestones for success that can be tracked annually.
H. **IDENTIFY INDICATORS TO MEASURE PROGRESS:** The Plan Implementation & Evaluation section can be used to determine whether milestones are being achieved over time, substantial progress is being made towards the goals and objectives, and if not, criteria for determining whether this plan needs to be revised.
I. **DEVELOP A MONITORING PLAN:** The Plan Implementation & Evaluation section describes the long-term monitoring strategy for the Hampton-Seabrook Estuary, the results of which can be used to evaluate the effectiveness of implementation efforts over time as measured against the criteria in (H) above. The success of this plan can only be evaluated with ongoing monitoring and assessment.

Current Environmental Conditions & Uses of the Estuary

The following section describes the current environmental conditions and uses of the Hampton-Seabrook Estuary, including an overview of climate; tides, streamflow, and flooding; water quality; sand dunes, beaches, and shoreline; salt marsh and vegetation; watershed land use; conservation areas; fish, birds, and other wildlife; shellfish and harvesting; and other recreational and commercial uses.

Climate Overview

The Hampton-Seabrook Estuary watershed is **situated within a temperate zone of converging weather patterns** from the hot, wet southern regions and the cold, dry northern regions, which causes various natural phenomena such as heavy snowfalls, severe thunder and lightning storms, and hurricanes. The area experiences moderate to high rainfall and snowfall, averaging 48 inches of precipitation annually (data collected for the period 1950-2021 from the North Hampton, NH US weather station (USC00276070) with gaps covered by the following weather stations: Newburyport, MA US (USC00195285), Portsmouth Pease AFB, NH US (USW00004743), Portsmouth, NH US (USC00276980), and Concord Municipal Airport, NH US (USW00014745) (Figure 3). Annual air temperature (from average monthly data) generally ranges from 30 °F to 60 °F with an average of 47 °F (NOAA, 2022).

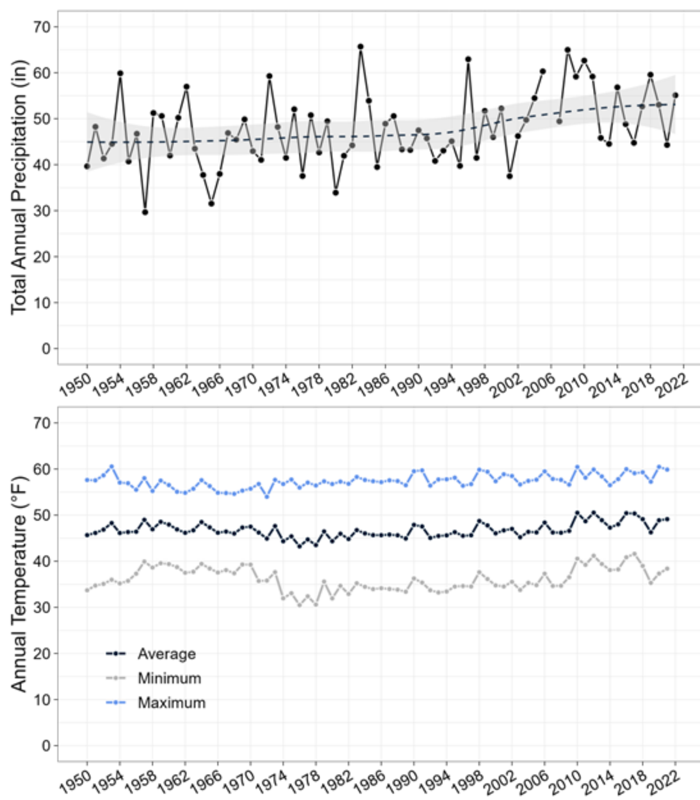


Figure 3*. Total annual precipitation (TOP) and annual max, average, and min of monthly air temperature (BOTTOM) from 1950 - 2021 for the Hampton-Seabrook Estuary area. Data collected from NOAA NCEI.*

As a result of anthropogenic climate change over the last century, average annual air temperature in New England has risen by 1.0-2.3 °C, with even greater increases in winter air temperature observed (IPCC, 2013). These **warming air temperatures have generated a rise in sea level and changes in precipitation patterns** such that flood and drought periods are becoming more frequent and severe. Global sea level has risen an average of 6.7 inches in the last 100 years. Since 1993, sea level in New Hampshire has risen at a rate of 1.3 inches per decade compared to a rate of 0.7 inches per decade from 1900 to 1993 (PREP, 2018). From 1912 to 2018, sea level has risen 7.5-8.0 inches based on tide gauge data from Seavey Island and Portland, ME; since the installation of the Seavey Island gauge in 1926, sea level has risen 0.07 inches/year (Wake, et al., 2019). Since the 1950s, the magnitude of daily extreme precipitation events has increased by 15-38% in New Hampshire coastal watersheds (Wake, et al., 2019). The combination of coastal inundation from sea level and groundwater rise and storm surges following large precipitation events are putting **communities and infrastructure at great risk due to more frequent, intense, and prolonged flooding.**

Tides, Streamflow, & Flooding

"High Tide November 16, 2020 on the marsh side of Hampton Beach." Credit: Marie Sapienza.

The Hampton-Seabrook Estuary is a tidally influenced system because of its connection with the Atlantic Ocean at the mouth of the Hampton River in Hampton Harbor, which exchanges 88% of its volume during each tide under average conditions (Nash & Dejadon, 2019). Water levels within the expansive system of tidal rivers and salt marsh fluctuate according to a **semi-diurnal tidal cycle that experiences roughly two high tides and two low tides of differing sizes each day**, depending on whether the estuary is experiencing spring, neap, or perigean (King Tides) tidal cycles. Data from the NOAA tide station (ID 8429489) located in Hampton Harbor indicates a mean tidal height of 8.3 feet, a spring tidal height of 9.5 feet, and a mean higher high water (MHHW) tidal height of about 9.0 feet above mean lower low water (MLLW) of 0 feet or sea level (Nash & Dejadon, 2019; SLR, 2021). Another tide station nearby to the estuary is Fort Point in New Castle, NH where MHHW is reported to be up to 9.4 feet above MLLW at sea level (RPC, 2009).

High tides in Hampton Harbor regularly exceeded 10 feet MLLW on 30-40% of days each year from 2013-2020, causing road inundation and property flooding in low-lying areas of Hampton including the Hampton Beach Village District (Chin & Howard, 2021). The NHDES Coastal Program found that **high tide flooding occurred three times more frequently** than predicted by NOAA tide charts because of severe weather and storm surges (Chin & Howard, 2021). In 2018, Hampton Harbor experienced 40 high tides between 11.0 and 11.9 feet and seven high tides measuring 12.0 feet or higher. Winter Storm Greyson in January 2018 and Winter Storm Riley in March 2018 created storm surge-driven high tides exceeding 13.2 and 12.8 feet, respectively (SLR, 2021). Although there are limited records on the number of high tide flood events in coastal New Hampshire, qualitative records of flooding exist, such as through the New

Hampshire CAW's King Tide annual photo contest. Decades of data from tide gauges across the U.S. show increases in high tide flooding. Along the northeastern U.S. coast, the frequency of **high tide flooding from 2000-2015 increased an average of 75%**, from 3.4 to 6.0 days per year (Wake, et al., 2019).

September 11, 2022 4-9" deep flood waters in the Greene St, Meadow Pond, Gentian Rd area in Hampton. Credit: Tom Bassett.

Coastal communities are highly susceptible to flooding due to their low-lying elevation, flat topography, and proximity to water resources. **Coastal flooding can be caused by any combination of high wind and wave action, storm surges, tidal events (spring and King tides), and sea level and groundwater rise associated with climate change.** Other factors that compound and complicate flooding in coastal areas include the presence of high water tables, soils with low infiltration rates, and/or saturated soils that inhibit water from infiltrating into subsurface areas (EF Design & Planning, LLC, 2019). The presence of dams or undersized culverts along tributaries to the estuary restricts the free movement of water in response to these flooding pressures which can further exacerbate the impacts of flooding on the landscape. Greater volumes of water coming into the estuary from landscape-derived freshwater streamflow following large precipitation events conflate flood levels with marine-derived high tides, storm surges, and sea level rise. Out of 28 rural stream flow stations throughout New England, 25 showed increased flows over the record, likely due to increases in the frequency of extreme precipitation and total annual precipitation in the region. In 79 years of recorded flooding in the Oyster River in Durham, NH, three of the four highest floods occurred in the 10 years prior to 2017 (Ballestero, Houle, Puls, & Barbu, 2017).

The Federal Emergency Management Agency (FEMA) produces flood hazard maps for communities through the NFIP. These maps serve as a resource for understanding and insuring against flood risk. FEMA's flood zones are based on the 100-year flood frequency (1% chance of being flooded during any year) and 500-year flood frequency (0.2% chance of being flooded during any year). When mapped, there is a small difference between the total area inundated with floodwaters under each scenario. Relating this to a homeowner's mortgage, there is a **one-in-four chance over a 30-year mortgage that a 100-year storm could occur and potentially cause flooding or damage** (Wake, et al., 2019). FEMA reports that just **one inch of floodwater can cause up to $25,000 in damage to a home** (FEMA, n.d.). The baseline for determining the volume of precipitation produced by a 100-year storm comes from historical records of precipitation, groundwater and streamflow records, and computer modeling results. These models do not include projections of climate change impacts on flooding hazard severity, most notably future increases in sea level and storm intensity and frequency. Currently, the National Weather Service (NWS) reports that a rainfall event producing between 6.29 and 12.3 inches of rain within a 24-hour period is classified as a 100-year storm event in New Hampshire (National Weather Service, n.d.).

> **Floodplains** are areas of low elevation adjacent to streams, rivers, estuaries, coasts, or other surface waters into which a waterbody overflows during high flow events such as heavy rain, storm surges, or snowmelt. Even though floodplain areas are inherently subject to regular and reoccurring flooding, the frequency, impact, and extent of this flooding is increasing.

All three towns surrounding the Hampton-Seabrook Estuary have large areas of land that are subject to flooding. In Hampton, approximately 2,968 acres of land are within the FEMA 100-year **floodplain**. Of this, approximately 471 acres (16%) are developed, including 278 acres of residential development. Approximately 32 acres of land beyond the 100-year floodplain are within the 500-year floodplain (EF Design & Planning, LLC, 2019). About 4% of structures in Hampton are within "high flood risk" areas (Zones AO and VE), with beaches accounting for 2% of the Town's area (Town of Hampton, NH, 2021). From 2011-2015, the average number of floods that occurred in Hampton averaged about three per year (EF Design & Planning, LLC, 2019). Approximately 1,542 acres of land in the Town of Hampton Falls are within the 100-year floodplain, with 46 additional acres within the 500-year floodplain (Town of Hampton Falls, NH, 2019). The Town of Seabrook outlines the number of acres anticipated to fall within the 100-year and 500-year floodplains for various sea level rise scenarios but does not report current areas within the two floodplains in their master plan. In a sea level rise scenario of 1.7 feet, Seabrook would have 1,730 acres of land within both the 100- and 500-year floodplains (Town of Seabrook, NH, 2011).

Another metric that serves as a proxy for a community's vulnerability to flooding is the **number of policyholders in the FEMA's NFIP**. In the Town of Hampton, 1,769 NFIP policies exist with, on average, 24 claims and nearly $200,000 paid to property owners each year (Town of Hampton, NH, 2021; EF Design & Planning, LLC, 2019). These **losses in Hampton account for 42% of the flood-related losses and damages in the last 32 years within Rockingham County and 20% of the losses statewide**. Hampton has the greatest number of repetitive losses in New Hampshire at 124 properties, of which 37 are residential (EF Design & Planning, LLC, 2019). In New Hampshire, flooding accounts for 60% of the presidentially declared disasters and emergency declarations and 67% of federal reimbursement provided by FEMA for those disasters and declarations (Wake, et al., 2019). Some notable natural disasters that have caused flooding in the Hampton-Seabrook Estuary watershed include the "Perfect Storm" of 1991, the "Mother's Day" storm of 2006, the "Patriots Day" storm of 2007, and "Superstorm Sandy" of 2012 (Town of Seabrook, NH, 2011). The low-lying areas adjacent to the salt marsh and beaches in Hampton and Seabrook are most vulnerable to flooding. In the last 15 years, flood damage has occurred at Secord's Pond, the upper reaches of Cains Brook, and Noyes Pond where there has been sediment deposition, severe erosion, and destruction of beaver dams (Town of Seabrook, NH, 2011).

Water Quality

Applicable Water Quality Standards & Criteria

New Hampshire is required to follow federal regulations under the Clean Water Act (CWA), albeit with some flexibility as to how those regulations are enacted. The main components of water quality regulations include designated uses, water quality criteria, and antidegradation provisions. Along with the CWA, the NH *RSA 485-A Water Pollution and Waste Control* and the NH Surface Water Quality Regulations (Env-Wq 1700) are the regulatory bases by which water quality in New Hampshire is protected (Wood & Edwardson, 2022; NHDES, 2016). These regulations dictate New Hampshire's regulatory and permitting programs related to surface waters. All states, including New Hampshire, are required to submit biennial water quality status reports to Congress via the U.S. Environmental Protection Agency. These reports provide an inventory of all waters assessed by each state and indicate which waterbodies do not meet the state's water quality standards and are therefore impaired. These reports are commonly referred to as the "Section 303(d) lists" and the "Section 305(b) reports."

Designated Uses & Water Quality Classification

The CWA requires states to determine designated uses for all surface waters within the state's jurisdiction. Designated uses are the desirable activities and services that surface waters should be able to support, including uses for aquatic life, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating and fishing), and wildlife (Table 1). Surface waters often have multiple designated uses. In New Hampshire, all surface waters are also legislatively classified as Class A or Class B, most of which are Class B (Wood & Edwardson, 2022). Brief descriptions of these classes are provided in Table 2. Once this classification is established, water quality criteria are then developed to protect the designated uses within waterbodies. These water quality criteria can be more or less restrictive depending on the waterbody classification (Class A or Class B) and the designated uses present. All waterbodies in the Hampton-Seabrook Estuary watershed are Class B.

Table 1. *Designated uses for New Hampshire surface waters (Wood & Edwardson, 2022).*

Designated Use	NH Code of Administrative Rules (Env-Wq 1702.17) Description	Applicable Surface Waters
Aquatic Life Integrity	The surface water can support aquatic life, including a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of the region.	All surface waters
Fish Consumption	The surface water can support a population of fish free from toxicants and pathogens that could pose a human health risk to consumers.	All surface waters
Shellfish Consumption	The tidal surface water can support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.	All tidal surface waters
Potential Drinking Water Supply	The surface water could be suitable for human intake and meet state and federal drinking water requirements after adequate treatment.	All surface waters
Primary Contact Recreation	Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water	All surface waters
Secondary Contact Recreation	Waters that support recreational uses that involve minor contact with the water.	All surface waters
Wildlife	The surface water can provide habitat capable of supporting any life stage or activity of undomesticated fauna on a regular or periodic basis.	All surface waters

Table 2. *New Hampshire surface water classifications (Wood & Edwardson, 2022).*

Classification	Description (RSA 485-A:8)
Class A	These are generally of the highest quality and are considered potentially usable for water supply after adequate treatment. Discharge of sewage or wastes is prohibited to waters of this classification
Class B	Of the second highest quality, these waters are considered acceptable for fishing, swimming and other recreational purposes, and, after adequate treatment, for use as water supplies

Water Quality Criteria

New Hampshire's water quality criteria provide a baseline measure of water quality that surface waters must meet to support designated uses. These criteria are a means of identifying water quality problems and determining the effectiveness of state regulatory pollution control and prevention programs. If the existing water quality meets or is better than the water quality criteria, the waterbody supports its designated use(s). If the waterbody does not meet water quality criteria, then it is considered impaired for its designated use(s).

Water quality criteria for each classification and designated use in New Hampshire can be found in RSA 485 A:8, IV and in the state's surface water quality regulations (Wood & Edwardson, 2022). The designated uses applicable for waterbodies in the Hampton-Seabrook Estuary watershed include Aquatic Life Integrity, Fish Consumption, Shellfish Consumption, Potential Drinking Water Supply, Primary Contact Recreation, and Secondary Contact Recreation. A list of the primary and secondary numeric/narrative water quality criteria used to assess each designated use for New Hampshire waterbodies is shown in Table 3. Refer to Table A-1 in Appendix A for applicable designated uses and their support or non-support status by parameter for each Assessment Unit (AU) in the Hampton-Seabrook Estuary watershed.

Table 3. *List of primary and secondary numeric/narrative water quality criteria for each designated use in the Hampton-Seabrook Estuary watershed (Wood & Edwardson, 2022). Geo = geometric mean of multiple samples. Instan = instantaneous, single grab sample. Enterococci (Entero) and E. coli units are in MPN/100mL. TP = total phosphorus.*

Designated Use	Primary Numeric/Narrative Criteria	Secondary Numeric/Narrative Criteria
Aquatic Life Use	Biological assessments (macros & fish)	Habitat assessments, channel stability
	DO > 5 mg/L & 75% saturation	Chronic/acute toxics
	6.5 < pH < 8.0	Invasives, Turbidity, TP, Flow
Potential Drinking Water Supply*	Treatment tech. exists to produce safe drinking water	Chronic/acute toxics
Primary Contact Recreation	Freshwater (beach): *E. coli* < 88 (Instan), 47 (Geo)	Freshwater: Chlorophyll-a < 15 µg/L
	Estuarine (beach): Entero < 104 (Instan), 35 (Geo)	Estuarine: Chlorophyll-a < 20 µg/L
	Freshwater (no beach): *E. coli* < 406 (Instan), 126 (Geo)	Discharge of untreated sewage
	Estuarine (no beach): Entero < 104 (Instan), 35 (Geo)	Presence of cyanobacteria or other scums
Secondary Contact Recreation	Freshwater: *E. coli* < 765 (Instan), 235 (Geo)	Discharge of untreated sewage
	Estuarine: Entero < 520 (Instan), 175 (Geo)	Obstructions to boating by infill
Fish Consumption	Freshwater: Mercury in fish tissue	Other toxics in fish tissue
	Estuarine: Mercury and PCBs in fish tissue	Toxics in water
Shellfish Consumption	Fecal coliform < 14 (Geo), 43 (90th percentile)	
	Mercury and PCBs in fish tissue	

**Note that both Class A and B waters shall be considered potentially acceptable for water supply uses after adequate treatment (even if not currently used as such).*

Antidegradation Provisions

The Antidegradation Provision (Env-Wq 1708) in New Hampshire's water quality regulations serves to protect or improve the quality of the state's waters. The provision outlines limitations or reductions for future pollutant loading. Certain development projects (e.g., projects that require Alteration of Terrain Permit or 401 Water Quality Certification) may be subject to an Antidegradation Review to ensure compliance with the state's water quality regulations. The Antidegradation Provision is often invoked during the permit review process for projects adjacent to waters that are designated impaired, high quality, or outstanding resource waters. While NHDES has not formally designated high-quality waters, unimpaired waters are treated as high quality with respect to issuance of water quality certificates. Antidegradation requires that a permitted activity cannot use more than 20% of the remaining assimilative capacity of a high-quality water on a parameter-by-parameter basis. For impaired waters, antidegradation requires that permitted activities discharge no additional loading of the impaired parameter to the waterbody.

Waterbody Assessments

NHDES has defined and evaluated the water quality of 105 surface water AUs within the Hampton-Seabrook Estuary watershed. For each AU, the corresponding designated uses and applicable water quality criteria are assessed against available data. Assessment results for the 105 AUs are presented in Table A-1 in Appendix A.

Fish Consumption

The designated use of fish consumption was evaluated for all 105 AUs in the watershed using quantitative criteria for mercury and/or polychlorinated biphenyls (PCBs), the latter parameter for estuarine AUs only. As of the 2020/2022 reporting cycle, all 105 AUs in the watershed were determined to be marginally impaired for fish consumption, with all freshwater segments (lakes, rivers, and impoundments) having a Total Maximum Daily Load (TMDL) in place (4A-M) and all estuarine segments requiring a TMDL (5-M). One AU, Hampton Falls River-Winkley Brook (NHRIV600031003-01), was also assessed for fish consumption using criteria for copper and was determined to be potentially attaining standards (3-PAS); however, there were insufficient data to make an official assessment. Overall, no waterbodies in the Hampton-Seabrook Estuary watershed fully support fish consumption. See Table A-1, Appendix A.

Shellfish Consumption

The designated use of shellfish consumption was evaluated for 25 estuarine AUs using quantitative criteria for four parameters: dioxin (including 2,3,7,8-TCDD), fecal coliform, mercury, and PCBs. For dioxin, mercury, and PCBs, all AUs were determined to be marginally impaired for shellfish consumption and require a TMDL (5-M). For fecal coliform, 16 AUs were determined to be severely impaired with a TMDL in place (4A-P); three were marginally impaired with a TMDL in place (4A-M); and six were potentially not attaining standards (3-PNS); however, there were insufficient data to make an official assessment. Overall, no estuarine waterbodies in the Hampton-Seabrook Estuary watershed fully support shellfish consumption, though shellfish harvesting is conditionally approved in portions of Hampton Harbor. See Table A-1, Appendix A. See section on Shellfish & Harvesting for more details.

Potential Drinking Water Supply

The designated use of potential drinking water supply was evaluated for 24 AUs in the watershed using quantitative criteria for three parameters: fecal coliform, *E. coli*, and copper. For fecal coliform, 21 of 23 assessed AUs were determined to be potentially not attaining standards (3-PNS); the remaining two assessed AUs were determined to be potentially attaining standards (3-PAS). One AU, Hampton Falls River-Winkley Brook (NHRIV600031003-01), was assessed for potential drinking water supply using criteria for *E. coli* and copper and was determined to be potentially not attaining standards (3-PNS) for *E. coli* and potentially attaining standards (3-PAS) for copper. Overall, waterbodies in the Hampton-Seabrook Estuary watershed show some evidence for not fully supporting potential drinking water supply, though more data are necessary. See Table A-1, Appendix A.

Roughly 61% of Hampton's aquifers are within the Town's Aquifer Protection Area, which protects the highest quality aquifers and includes five active and four inactive public water systems. Aquarion Water Company manages Hampton's water system, providing service to approximately 17,000 locations in the Town. Small aquifer areas also exist in the towns of Seabrook and Hampton Falls.

Aquatic Life Integrity

The designated use of aquatic life integrity was evaluated for 13 AUs in the watershed using quantitative criteria for the following parameters: fish bioassessments, various toxins, various metals, turbidity, chloride, dissolved oxygen, pH, and phosphorus. Three of 13 assessed AUs were determined to be attaining standards (2-G and 2-M) or potentially attaining standards (3-PAS) for several parameters. The Hampton River Boat Club Safety Zone (NHEST600031003-04) was determined to be attaining for ammonia, dissolved oxygen saturation, and pH; Tide Mill Creek (NHEST600031004-03-03) was determined to be potentially attaining for residual chlorine; and Hampton Falls River-Winkley Brook (NHRIV600031003-01) was determined to be attaining for fish bioassessments and potentially attaining for aluminum, chloride, copper, dissolved oxygen saturation, dissolved oxygen, lead, phosphorus, turbidity, and pH. However, 10 of 13 AUs were determined to be impaired for aquatic life integrity for one or more parameters. Four AUs were determined to be severely impaired for dissolved oxygen and in need of a TMDL (5-P). Six AUs were determined to be marginally impaired for pH and in need of a TMDL (5-M). Four AUs were determined to be marginally impaired for one or more metals (aluminum, barium, copper, iron, lead, mercury, nickel, and zinc) and in need of a TMDL (5-M), with one additional AU severely impaired for metals. Three AUs were determined to be marginally impaired for other toxins (e.g., anthracene, arsenic, PAHs) and in need of a TMDL (5-M). The majority of and remaining AUs lack sufficient data for an official assessment. Of those AUs with official assessments, most do not fully support the designated use of aquatic life integrity. See Table A-1, Appendix A.

Primary Contact Recreation

The designated use of primary contact recreation was evaluated for 13 AUs in the watershed using quantitative criteria for three parameters: *E. coli*, enterococcus, and chlorophyll-a. Three of five assessed freshwater AUs were determined to be severely impaired for *E. coli* with a TMDL in place (4A-P); one marginally impaired with a TMDL in place (4A-M); and one potentially not attaining standards (3-PNS). One of seven assessed estuarine AUs was determined to be severely impaired for enterococcus with a TMDL in place (4A-P); two marginally impaired with a TMDL in place (4A-M); two potentially not attaining standards (3-PNS); and two marginally attaining standards (2-M). One assessed estuarine AU was determined to be potentially attaining standards (3-PAS) for chlorophyll-a. The majority of and remaining AUs lack sufficient data for an official assessment. Of those AUs with official assessments, most do not fully support the designated use of primary contact recreation. See Table A-1, Appendix A.

Secondary Contact Recreation

The designated use of secondary contact recreation was evaluated for 10 AUs in the watershed using quantitative criteria for three parameters: *E. coli*, enterococcus, and sedimentation/siltation. Two of five assessed estuarine AUs were determined to be attaining standards (2-G and 2-M) for enterococcus; one potentially attaining standards (3-PAS); one marginally impaired with a TMDL in place (4A-M); and one severely impaired and in need of a TMDL (5-P). One of four assessed freshwater AUs were determined to be severely impaired for *E. coli* with a TMDL in place (4A-P); two marginally impaired with a TMDL in place (4A-M); and one potentially not attaining standards (3-PNS). One freshwater AU was determined to be potentially attaining standards (3-PAS) for sedimentation/siltation. The majority of and remaining AUs lack sufficient data for an official assessment. Of those AUs with official assessments, more than half do not fully support the designated use of secondary contact recreation. See Table A-1, Appendix A.

Water Quality Summary

Within the NHDES Environmental Monitoring Database (EMD), data for key water quality parameters exist for 50 of the 105 AUs within the Hampton-Seabrook Estuary watershed. These data have been sampled as a part of multiple programs dating back to 1986 and cover the complete spectrum of taxonomic, chemical, physical, biological, and continuous water quality parameters. These data were averaged by site and parameter in supplementary tables and are summarized for major parameters below. Refer to Figure 4 for primary water quality station locations.

<u>Nitrogen</u>

In marine waters, nitrogen is typically the limiting nutrient for growth. Excess nutrients, including nitrogen, from anthropogenic sources such as fertilizers, livestock waste, pet waste, and atmospheric deposition (vehicle or industrial emissions) in stormwater runoff, as well as human wastewater effluent from treatment plants, malfunctioning septic systems, or leaky sewer lines, can lead to cultural eutrophication of surface waters. Eutrophic surface waters with high nitrogen concentrations experience nuisance plant and algae growth that can deplete dissolved oxygen concentrations and depress native species populations such as eelgrass.

In the Hampton-Seabrook Estuary watershed, there is minimal historic nitrogen data for surface waters. Of the data available, most stations are confined to estuarine waters and major freshwater rivers and lakes. In the NHDES EMD, across 46 stations in 18 AUs within the watershed, there are 1,026 observations of eight nitrogen species (ammonia, dissolved nitrogen, total Kjeldahl nitrogen, nitrate + nitrite, nitrate, nitrite, organic nitrogen, and suspended nitrogen). For ammonia, nitrate, and nitrite, average concentrations by station are generally low (<0.1 mg/L) with only a few stations showing higher concentrations. For dissolved and total Kjeldahl nitrogen, average concentrations by station typically range from 0.1 to 0.5 mg/L, with stations in freshwater lakes and rivers having higher values. The most sampled stations are HHHR in the Hampton River Boat Club Safety Zone, NH-0004A and NH-0007A in Hampton Harbor, and NH-0009A in the Hampton Falls River (WWTF Safety Zone), all of which show low average nitrogen concentrations. See Table S2 in the HSE EMP Supplementary Document.

The main sources of nitrogen loading to the Hampton-Seabrook Estuary comes from atmospheric deposition (38,362 lbs./yr, 43.2%), chemical fertilizer (22,885 lbs./yr, 25.8%) largely from residential lawns, human waste (15.7%), and animal waste (15.3%) (PREP, 2015).

<u>Phosphorus</u>

In freshwater, phosphorus is typically the limiting nutrient for growth. Dissolved phosphorus is generally found in much lower concentrations than nitrogen because it is often bound in particulate form. Low oxygen concentrations can promote the release of particulate phosphorus into dissolved forms, thereby elevating phosphorus concentrations in surface waters. Anthropogenic sources of phosphorus include human, pet, and livestock waste, sediment erosion, and fertilizer.

In the Hampton-Seabrook Estuary watershed, there is minimal historic phosphorus data for surface waters. In the NHDES EMD, across 43 stations in 17 AUs within the watershed, there are 448 observations of two phosphorus species (total phosphorus and ortho-phosphate). For total phosphorus, average concentrations by station are generally low, ranging from 0.02 to 0.04 mg/L. Seven stations have total phosphorus concentrations greater than 0.04 mg/L, two of which exceed 0.20 mg/L and are in Hampton Harbor. For ortho-phosphate, average concentrations by station are also generally low, ranging from 0.01 to 0.03 mg/L except for two stations which were marginally higher at 0.04 and 0.06 mg/L. The most sampled stations are HHHR in the Hampton River Boat Club Safety Zone, NH-0004A and NH-0007A in Hampton Harbor, and NH-0009A in the Hampton Falls River (WWTF Safety Zone). See Table S2 in the HSE EMP Supplementary Document.

Organic Carbon

Elevated concentrations of organic carbon, both in particulate and dissolved forms, can degrade water quality by 1) reducing the amount of light available for submerged aquatic vegetation to undergo photosynthesis and 2) providing microorganisms with organic substrate to decompose and thereby consume and lower oxygen concentrations. In the NHDES EMD, across 25 stations in 11 AUs within the watershed, there are 196 observations of two organic carbon species (organic carbon and suspended carbon). All these stations only have one or two observations of each of these parameters except for four stations: HHHR in the Hampton River Boat Club Safety Zone, NH-0004A and NH-0007A in Hampton Harbor, and NH-0009A in the Hampton Falls River (WWTF Safety Zone). For organic carbon, average concentrations at these stations are above the recommended criterion of 2.0 mg/L, ranging from 2.1 – 13.6 mg/L. For suspended carbon, average concentrations are lower, ranging from 0.3-1.3 mg/L. See Table S2 in the HSE EMP Supplementary Document.

Dissolved Oxygen

Virtually all aquatic organisms require dissolved oxygen to survive, and as a result, it is one of the most important water quality parameters to monitor. Low dissolved oxygen (concentrations below 5 mg/L and 75% saturation) pose a risk to ecosystem health by restricting the habitat range of organisms that require more oxygen. Unlike nutrients, however, dissolved oxygen measurements can be made *in-situ* using field meters and data loggers, allowing for potentially more observations at a lower cost.

Like nitrogen and phosphorus, there is relatively little historical data coverage of dissolved oxygen concentrations in the Hampton-Seabrook Estuary watershed compared to other areas (Jones, 2000). In the NHDES EMD, across 59 stations in 24 AUs within the watershed, there are 1,609 observations of dissolved oxygen and dissolved oxygen saturation. Three stations, TR-W-01 and TR-W-03 in Taylor River Refuge Pond and NH07-0016A in Mill Creek, had average dissolved oxygen concentrations below 5 mg/L. For dissolved oxygen saturation, 18 stations in 9 AUs had average values below 75%. See Table S3 in the HSE EMP Supplementary Document.

High temporal resolution of dissolved oxygen data from data loggers are also available for the Hampton-Seabrook Estuary watershed at five stations in three AUs (Hampton River Boat Club Safety Zone, Taylor River Refuge Pond, and Meadow Pond). In the Hampton River Boat Club Safety Zone, there are 67,869 observations of dissolved oxygen at one station (HHHR) ranging from 0.5-12.9 mg/L, of which 5% fall below 5 mg/L. At the same station, there are 70,066 observations of dissolved oxygen saturation ranging from 1-154%, of which 13% fall below 75%. Three stations in the Taylor River Refuge Pond have dissolved oxygen data: 03-TLR, TR-W-06, and TR-W-01. These stations have 950, 2,187, and 2,186 observations which fall below 5 mg/L 0%, 40%, and 55% of the time, respectively. Dissolved oxygen saturation was measured only at 03-TLR, with 950 values ranging from 61-103%, of which 5% fall below 75%. In Meadow Pond, there are 378 observations of dissolved oxygen ranging from 6.0-8.5 mg/L at one station (NC20) and 378 observations of dissolved oxygen saturation ranging from 68-94% with 16% falling below 75%. See Table S5 in the HSE EMP Supplementary Document.

Total Suspended Solids (TSS)

Like organic carbon, too much suspended material in the water column can degrade water quality by limiting the amount of light available for submerged aquatic vegetation. In the NHDES EMD, across 30 stations in 11 AUs within the watershed, there are 201 observations of Total Suspended Solids (TSS). Twenty-three (23) stations have only three observations or less, with values at those stations ranging from 3-38 mg/L. Four stations in three AUs (Hampton River Boat Club Safety Zone, Hampton Falls River (WWTF Safety Zone), and Hampton Harbor) have more than 25 observations of TSS ranging from 12-21 mg/L. See Table S3 in the HSE EMP Supplementary Document.

Specific Conductance

Specific conductance is an indirect measure of the dissolved ions in water and is widely used as a basic water quality indicator in freshwater systems because pollutants (such as ionized nutrients) can increase the number of ions in the water. Marine waters naturally have high conductivity due to the large number of dissolved salts present. As a result, specific conductivity is not an effective water quality indicator in estuaries and instead serves as a proxy for salinity, which is driven largely by tidal stage and precipitation.

Similar to dissolved oxygen, there is minimal historical data for specific conductance in the Hampton-Seabrook Estuary watershed. In the NHDES EMD, across 28 stations in 15 AUs within the watershed, there are 637 observations of specific conductivity. One station is located in the estuary with only one observation, while the remaining stations are located in lakes, rivers, and impoundments. Two of the 27 freshwater stations have average specific conductivities exceeding the guidance threshold of 835 µS/cm: TR-W-12 in the Taylor River from Rice Dam to Taylor River Refuge Pond and MEAHAMD in Meadow Pond. The other stations have average specific conductivities ranging from 187-702 µS/cm. See Table S3 in the HSE EMP Supplementary Document.

High temporal resolution of specific conductivity data from data loggers are also available for the Hampton-Seabrook Estuary watershed at six stations in four AUs (Hampton River Boat Club Safety Zone, Taylor River Refuge Pond, Cains Brook-Noyes Pond, and Meadow Pond). In the Hampton River Boat Club Safety Zone, there are 69,697 observations of specific conductivity at one station (HHHR) ranging from 20-503 µS/cm. Three stations in the Taylor River Refuge Pond (03-TLR, TR-W-06, and TR-W-01) have 1,898, 2,187, and 2,186 observations, respectively, none of which exceed 835 µS/cm. In Cains Brook-Noyes Pond, there are 46,450 observations of specific conductivity at one station (02-CNS) ranging from 221-2,253, with 17% exceeding 835 µS/cm. In Meadow Pond, there are 378 observations of around 1 µS/cm. See Table S5 in the HSE EMP Supplementary Document.

pH

Waters that are either too acidic (pH<6.5) or too basic (pH>8.0) can have a negative impact on aquatic organisms that are sensitive to pH. This parameter is particularly important for calcifying organisms like clams, oysters, and mussels whose ability to build their shell is influenced by the chemistry of the water. In addition to external influences such as gas exchange with the atmosphere and the chemistry of the underlying soils, pH in coastal waterbodies is also influenced by the relative rates of photosynthesis and respiration since these factors regulate the concentration of dissolved carbon dioxide in water.

In the NHDES EMD, across 118 stations in 31 AUs within the watershed, there are 3,186 observations of pH. Fifty (50) stations have only three observations or less, with average values ranging from 6.0-8.1. The remaining 68 stations have between 4 and 147 observations each, with average values ranging from 6.2-8.2. Overall, there are six stations in four AUs with average pH values less than 6.5 and eight stations in six AUs with average pH values greater than 8.0. See Table S3 in the HSE EMP Supplementary Document.

High temporal resolution of pH data from data loggers are also available for the Hampton-Seabrook Estuary watershed at six stations in three AUs (Hampton River Boat Club Safety Zone, Taylor River Refuge Pond, and Meadow Pond). In the Hampton River Boat Club Safety Zone, there are 72,130 observations of pH at one station (HHHR) ranging from 6.9-8.4, of which 24% exceed the 8.0 criterion. Three stations in the Taylor River Refuge Pond (03-TLR, TR-W-06, and TR-W-01) have 1,898, 2,187, and 2,186 observations, respectively, none of which are outside the 6.5-8.0 range. In Meadow Pond, there are 378 observations of pH at one station (NC20) ranging from 6.8-7.6. See Table S5 in the HSE EMP Supplementary Document.

Phytoplankton/Chlorophyll-a

Chlorophyll-a is a photosynthetic pigment found in most phytoplankton and is often used as a proxy for phytoplankton abundance. Although phytoplankton are vital to marine food webs due to their roles as primary producers, too much phytoplankton can lead to poor water quality conditions such as reduced water clarity and decreased oxygen in bottom waters. As such, both direct counts of phytoplankton abundance and measurements of chlorophyll-a are important water quality parameters.

In the NHDES EMD, across 45 stations in 19 AUs within the watershed, there are 242 observations of chlorophyll-a (both corrected and uncorrected for pheophytin). Twenty-six (26) stations have only one observation each, with values ranging from <0.2-7.2 μg/L. Four stations have 30 or more observations each (HHHR in the Hampton River Boat Club Safety Zone, NH-0004A and NH-0007A in Hampton/Seabrook Harbor, and NH-0009A in the Hampton Falls River (WWTF Safety Zone)), with average values ranging from 1.4-4.1 μg/L. No stations had an average chlorophyll-a concentration exceeding the state freshwater criterion of 15 μg/L (or the state estuarine criterion of 20 μg/L). See Table S4 in the HSE EMP Supplementary Document.

High temporal resolution of chlorophyll-a data from data loggers are also available at one station (HHHR) within the Hampton River Boat Club Safety Zone. At this station, there are 15,072 observations of chlorophyll-a ranging from 0.9-366.0 μg/L. These observations were generally low, averaging 7.6 μg/L, but with 6% of values exceeding 20 μg/L. See Table S5 in the HSE EMP Supplementary Document.

Fecal Indicator Bacteria (*E. coli*, enterococcus, fecal streptococcus)

High counts of fecal indicator bacteria such as *E. coli*, enterococcus, and fecal streptococcus in surface waters pose a risk to human health due to the numerous pathogens associated with fecal bacteria. High fecal indicator bacteria levels are often associated with illicit discharges of human wastewater from sewers and malfunctioning septic systems, along with other potential fecal sources from pet, livestock, and wildlife waste in stormwater runoff or direct deposition. Fecal waste sources are difficult to track via fecal indicator bacteria for determining public health risk due to the inherent variability of fecal indicator bacteria growth, both in-situ and in the laboratory.

Although there are fecal indicator bacteria data for many stations in the Hampton-Seabrook Estuary watershed, most stations lack the amount of data required to properly assess the risk to public health. In the NHDES EMD, across 141 stations in 35 AUs within the watershed, there are 1,318 observations of enterococcus, *E. coli*, and fecal streptococcus. For enterococcus, 46 stations are in estuarine waterbodies, with 13 stations showing average concentrations that exceed the 35 MPN/100mL criterion; however, most stations have only one or two observations. For *E. coli*, 126 stations are in both estuarine and fresh waterbodies, with 45 stations showing average concentrations that exceed the 126 MPN/100mL criterion; however, most stations have only one observation. For fecal streptococcus, there are 22 stations with one observation each and values range from 20-390 MPN/100mL with an average of 125 MPN/100mL. See Table S4 in the HSE EMP Supplementary Document.

Based on fecal indicator bacteria data collected at beaches along the New Hampshire seacoast, beach conditions are generally good, with less than one percent of beach days experiencing an advisory.

Recommendations Based on Data Gaps

Within the Hampton-Seabrook Estuary watershed, there is a sufficient level of baseline monitoring across the watershed for parameters directly related to public health risks (e.g., mercury, fecal coliform, and PCBs sampled to evaluate fish/shellfish consumption and potential drinking water supply); however, there are only a few waterbodies that also have sufficient baseline water quality monitoring for other parameters. The Hampton River Boat Club Safety Zone (AUID=NHEST600031003-04, station ID=HHHR), Hampton/Seabrook Harbor (AUID=NHEST600031004-09-09, station ID=NH-0004A, NH-0007A), the Hampton Falls River WWTF Safety Zone (AUID=NHEST600031004-04-01, station ID=NH-0009A), and Taylor River Refuge Pond (AUID=NHLAK600031003-02, station ID=03-TLR, TR-W-01, TR-W-06) consistently have more data for almost all water quality parameters compared to other waterbodies in the watershed (Figure 4). This targeted sampling effort maximizes available resources by focusing on areas with critical habitat or known pollutant concerns, but it fails to provide a complete picture of water quality in the watershed. It is important that water quality sampling in these priority areas be continued to allow for continuous time series to be established; however, if additional resources become available, these efforts should be expanded to other high priority freshwater and estuarine segments in the watershed. More detailed review of available data and monitoring objectives is required to identify those high priority areas in the watershed.

In terms of specific parameters, one parameter that requires additional monitoring efforts to properly assess both primary and secondary contact recreation is fecal indicator bacteria. Currently 13 AUs have been assessed for primary contact recreation and 10 AUs for secondary contact recreation, with all other waterbodies left unassessed due to insufficient data. Although data for fecal indicator bacteria are available at 141 stations in 35 AUs, most of these stations have only one or two observations. To determine the scope of public health risks from recreation in the watershed, more bacteria data are needed for NHDES to properly assess primary and secondary contact uses.

Other parameters that have limited data within the watershed that would benefit from additional monitoring include dissolved oxygen, temperature, specific conductance, pH, chloride, chlorophyll-a, TSS, and nutrients. If resources are limited, parameters that can be measured using field instruments, such as dissolved oxygen, temperature, specific conductance, and pH, should be prioritized since they can be collected by volunteers trained through the NHDES Volunteer Lake Assessment Program (VLAP) or Volunteer River Assessment Program (VRAP) at little-to-no cost provided the appropriate instruments are available. This is especially relevant for dissolved oxygen and pH because both parameters are unassessed for aquatic life integrity use for most waterbodies in the watershed. Due to the high costs associated with laboratory analysis, the remaining parameters (chloride, chlorophyll-a, TSS, and nutrients) should be analyzed at waterbodies on a case-by-case basis depending on known stressors and historical water quality data. For example, a freshwater lake with low dissolved oxygen would be a good candidate for chlorophyll-a and phosphorus sampling to help determine if algae blooms are a potential cause and to see if internal phosphorus loading is occurring due to the low oxygen conditions. As another example, a waterbody adjacent to developed areas would be a good candidate for TSS and chloride (if freshwater) sampling to determine if erosion or road salt application during winter is impacting water quality. With this approach, available resources can be maximized to gain a greater understanding of water quality throughout the Hampton-Seabrook Estuary watershed.

Sand Dunes, Beaches, & Shorelines

The Hampton-Seabrook Estuary contains some of the last remaining sand dunes in New Hampshire (Jones, 2000). The dunes are located along the coast and near the mouth of Hampton Harbor adjacent to the U.S. Route 1A bridge connecting Seabrook and Hampton. The largest area of intact sand dune can be found in the Seabrook Dunes, west of U.S. Route 1A (Eberhardt & Burdick, 2008). This unique and rare ecological system **supports habitat and foraging for many threatened, endangered, and rare plant and animal species**. Dune community types include beach grass grassland, Hudsonia maritime shrubland, bayberry - beach plum maritime shrubland, and maritime wooded dune (Figure 5) (Eberhardt & Burdick, 2008). Sand dunes are classified into **three zones: foredune, interdune, and backdune**. **Foredunes** face the ocean and thus are highly exposed to the erosive forces of waves and wind. Foredunes are largely colonized by American beachgrass, which have dense root systems to stabilize the dune system. American beachgrass is a common and hardy plant found within dune systems and covers 71% of the current extent of sand dune habitat in the Hampton-Seabrook Estuary watershed (Eberhardt & Burdick, 2008); however, loss of beachgrass is a major concern for dune protection and restoration efforts. **Interdunes** are afforded some protection by the foredunes, allowing for a higher diversity of species colonization. **Backdunes** are the most stable of the three zones and are typically composed of shrubs and trees. The last remaining backdune in the state can be found in the Seabrook Dunes, making its maritime shrubland community type rare in New Hampshire (Figure 5) (Eberhardt & Burdick, 2008). Remnant foredunes and interdunes in the state are largely located in front of beachside homes along the coast.

Since 1776, the extent of **dune habitat in the Hampton-Seabrook Estuary watershed has declined by nearly 84%**, from 724 acres in 1776 to 119 acres in 2005 (Eberhardt & Burdick, 2008). The majority of sand dune loss along the New Hampshire coastline has been due to fill and development; however, disturbance from de-vegetating the dune, constructing walkways, and recreating have also played a role in decreasing sand dune habitat (Figure 6) (Eberhardt & Burdick, 2008). Development along the coast restricts the natural movement of sand into and out of the dune system, preventing the natural shifting of the shoreline in response to erosive forces such as wind, waves, and storms.

In addition to sand dunes, other coastal natural features such as beaches and rocky shorelines also serve as natural defensive barriers to help protect against storm surges and

> The planned replacement of the Neil R. Underwood Memorial Bridge (referred to as the **Hampton Harbor Bridge Project**) is necessary for public safety and transportation connectivity along the seacoast. The 2022 Environmental Assessment considered the potential impact of the project on the Hampton-Seabrook Dunes Wildlife Management Area (Dunes WMA) to the southwest of the existing bridge and found no significant impact and thus no mitigation necessary. However, appropriate BMPs should be put in place during construction to ensure no adverse impact to the dunes.

erosion. Hampton Beach, Seabrook Beach, and North Beach are the major sandy beaches located along Hampton and Seabrook's coastline. New Hampshire's coastline, including Hampton Harbor, has been hardened by tidal shoreline structures such as stone and concrete walls, jetties and groins, and rip rap revetments. For example, there is a large jetty/groin that extends into the Atlantic Ocean from the northern edge of Hampton Harbor's mouth. Hampton has 6.98 miles (19%) of armored and 29.15 miles of unarmored shoreline; Hampton Falls has 0.01 miles (1%) of armored and 1.88 miles of unarmored shoreline; and Seabrook has 2.38 miles (9%) of armored and 24.01 miles of unarmored shoreline (NHDES Coastal Program, 2016). These shoreline structures were built to stabilize and protect the tidal coastline; however, they also degrade shoreline habitat and the natural ability of coastal features to protect against storm surges and erosion.

Sand dune overlooking mudflat. © Matt Parker.

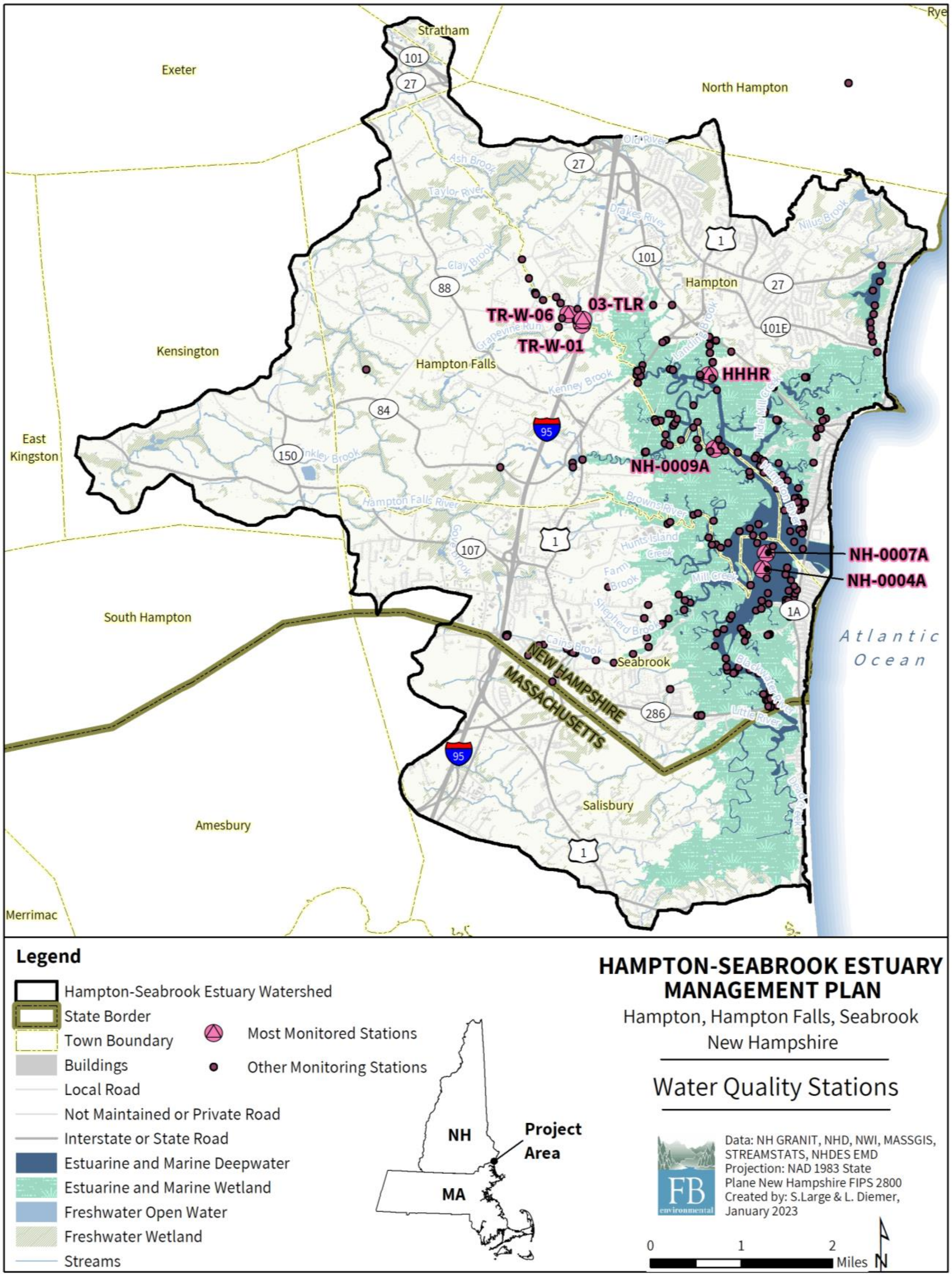


Figure 4. Water quality monitoring station locations in the Hampton-Seabrook Estuary watershed.

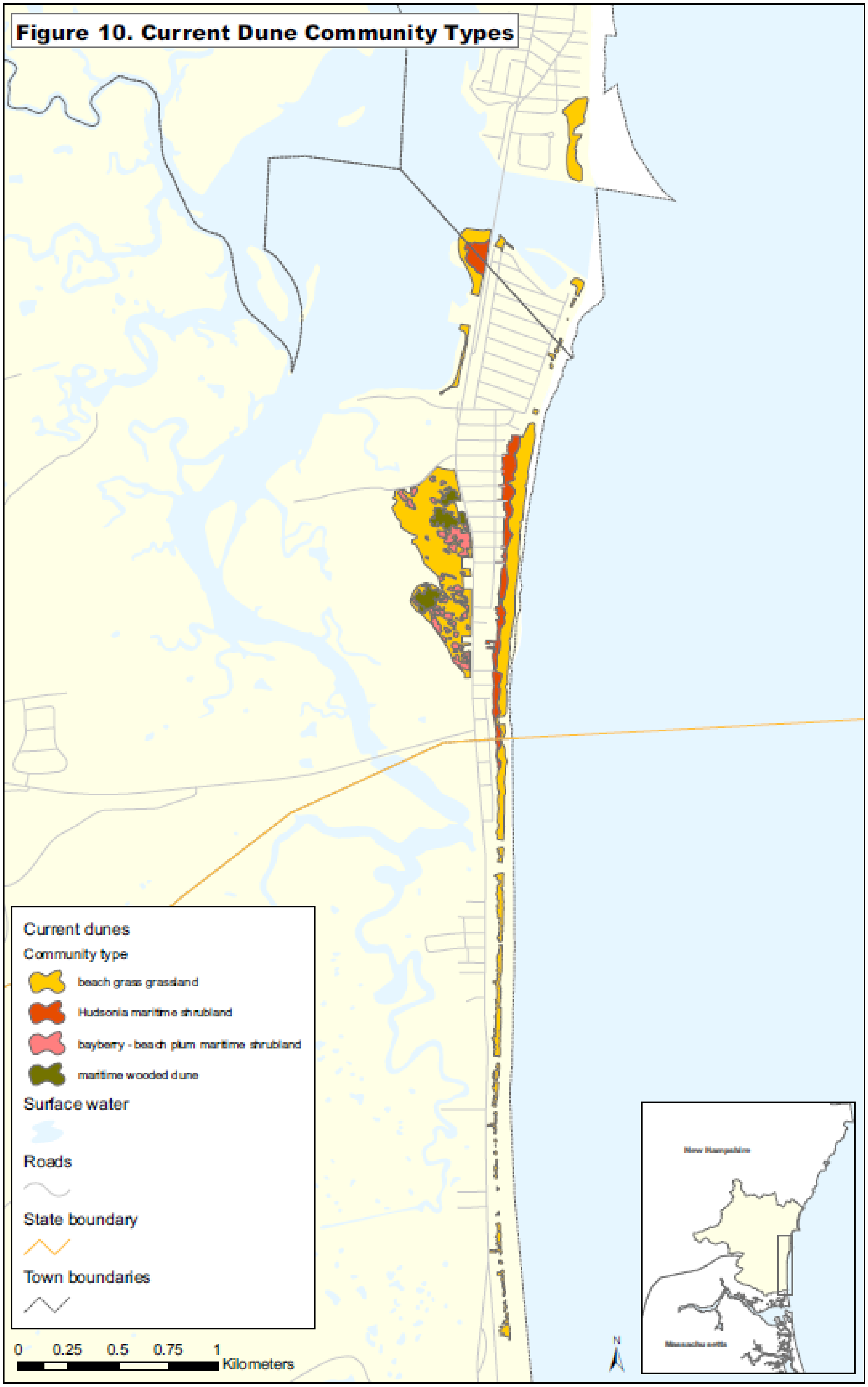


Figure 5. *Current dune community types along Hampton and Seabrook, NH (Eberhardt & Burdick, 2008).*

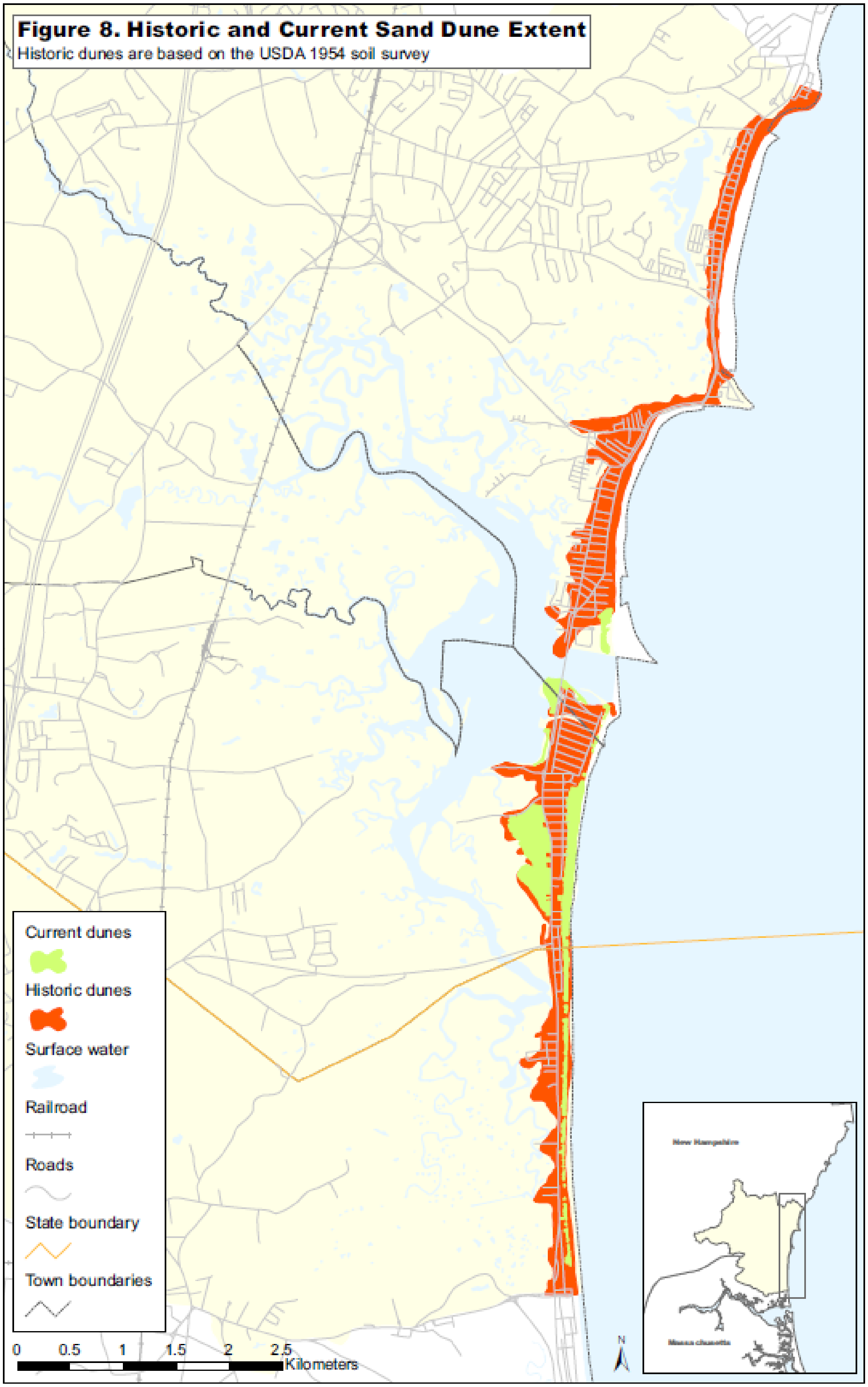


Figure 6. *Historic and current sand dune extent along Hampton and Seabrook, NH (Eberhardt & Burdick, 2008).*

Salt Marsh & Vegetation

One of the largest and most prominent natural features of the Hampton-Seabrook Estuary is the salt marsh, which is also the **largest continuous salt marsh in New Hampshire** (PREP, 2015). Salt marshes are intertidal areas composed of open grass meadows and narrow fringe systems. They are among the most productive ecosystems due to their high rate of plant growth (Eberhardt & Burdick, 2008). Salt marsh grasses form the vegetative structure of salt marsh ecosystems. In the northeastern U.S., salt marshes are primarily composed of perennial grasses such as *Spartina alterniflora* (smooth cordgrass), *Spartina patens* (salt meadow cordgrass), and *Distichlis spicata* (spike grass). Where tidal flow becomes restricted and salinity decreases, these grasses are replaced by more freshwater-tolerant plants such as *Typha angustifolia* (narrowleaf cattail) and *Typha latifolia* (broadleaf cattail) (Smith & Warren, 2012). Salt marshes contain many sub-habitat units, including high marsh, low marsh, brackish marsh, mudflat, pannes and pools, and open water. High resolution tidal wetland data on salt marsh habitats are available through the NH Coastal Viewer and are made possible through the work of various partners, including the Great Bay NERR, NHFG, and TNC.

The salt marsh and freshwater wetlands within the estuary's watershed serve many vital functions for surrounding communities - chief among them is **flood storage capacity** during storm events which reduces the risk of flood damage. Other vital ecological services provided by salt marshes include **shoreline stabilization, nutrient cycling, pollutant removal, and breeding refuge and forage habitat** for crustaceans, invertebrates, fish, and birds. Because of these services, salt marshes support a broad and diverse food web that contributes to the overall biodiversity and ecosystem health of the estuary (Eberhardt & Burdick, 2008).

Threats to the Hampton-Seabrook Estuary salt marsh include high marsh subsidence, pool expansion, habitat transition, prolonged flooding, and loss (Moore, n.d.). An estimated **614 acres of salt marsh in the Hampton-Seabrook Estuary watershed have already been lost** between the early 1900s and 2010, primarily due to tidal restrictions, invasive species colonization, fill, and ditch excavation (Figure 7) (PREP, 2018; Eberhardt & Burdick, 2008). More specifically:

(1) Tidal restrictions from infrastructure such as undersized bridges and culverts have reduced natural tidal flow exchange from Hampton Harbor to the upper marsh fringes in some areas, which alters habitat structure.

(2) Two invasive plant species targeted by NHDES for invasive species management and removal are *Lepidium spp.* (pepperweed) and *Phragmites australis* (common reed). Beginning in 2008, the NHDES Coastal Program monitors and implements control strategies for pepperweed at four sites within the Hampton-Seabrook Estuary watershed: one in Hampton, two in Seabrook, and one along I-95 in Hampton Falls. Through a USFWS grant from 2020-2022, NDHES, in partnership with a volunteer organization, Nature Groupie, completed intensive invasive species mapping of the New Hampshire coast and identified four new pepperweed sites in the Hampton-Seabrook Estuary watershed: one in Seabrook, two on residential properties in back barrier neighborhoods of Hampton, and one on Landing Rd in Hampton. NHDES counted over 11,000 pepperweed stems, which changed NHDES' management strategy for pepperweed from containment to eradication.

(3) Historically, some salt marsh areas were filled in to make way for development.

(4) In the 17th and 18th centuries, salt marsh ditching and haying by early European settlers in the Hampton-Seabrook Estuary watershed promoted a shift in dominant vegetation from *S. alterniflora* to historically more economically valuable grasses like *S. patens* (salt marsh hay) and *Juncus gerardii* (black grass) (Eberhardt & Burdick, 2008). Early European settlers ditched the salt marsh to drain and dry the land for use as pastureland. In the 20th century, ditching of the salt marsh was continued for mosquito control. Today, restoration efforts are underway to fill in historic ditches to promote sedimentation and vegetation re-establishment.

It is expected that more salt marsh will be lost in the future from sea level rise. As sea level rises, salt marshes typically adapt by migrating landward. For the Hampton-Seabrook Estuary and other salt marshes surrounded by development, there is limited natural, low-elevation upland area for migration of salt marshes, which will otherwise be drowned and converted to open water in the future. The **continued loss in salt marsh will increase local flood risk and reduce critical habitat** for a variety of wildlife. For this reason, it is essential that any open space upland of the estuary be protected from development and any unused developed areas be converted back to open space to allow for current and future salt marsh migration. Refer to the Future Threats section.

Salt marsh in the Hampton-Seabrook Estuary watershed. © Rayann Dionne.

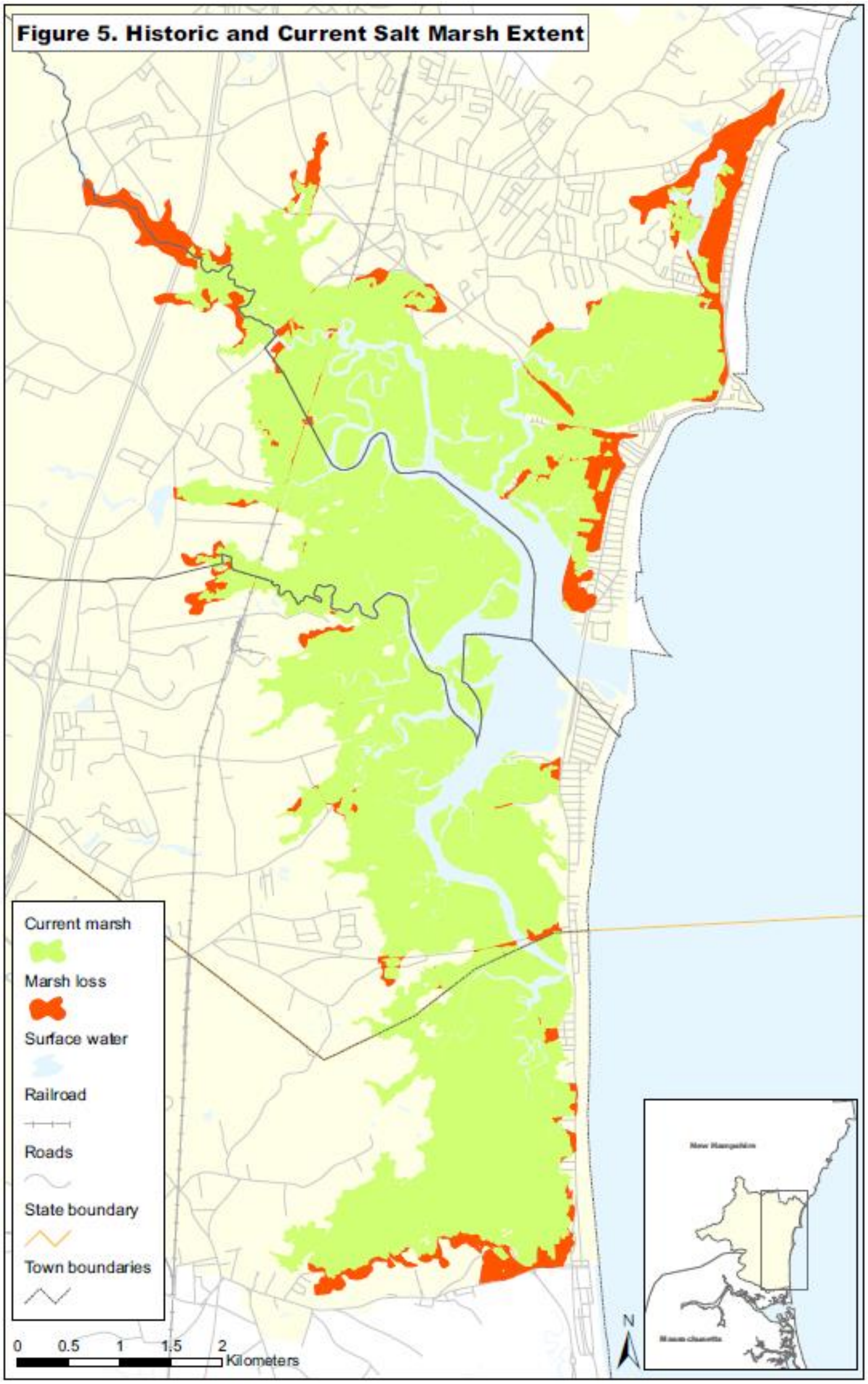


Figure 7. *Historic and current salt marsh extent in the Hampton-Seabrook Estuary watershed (Eberhardt & Burdick, 2008).*

Watershed Land Use

Characterizing watershed land use is essential for water resource protection as it can help to identify potential sources of pollution. For instance, a watershed with large areas of developed land and minimal forest will likely be more at risk for water quality and habitat degradation than a watershed with well-managed development and large tracts of undisturbed forest. A large amount of impervious surfaces within a watershed can cause high nutrient loading as atmospheric deposition on these surfaces allows nutrients to accumulate and eventually be transported to surface waters via stormwater runoff. Agricultural fields and residential neighborhoods can also be sources of nutrients to waterbodies through the application of fertilizers rich in nutrients to crop fields and lawns. The risk of other potential pollutant sources, including industrial discharges, septic tanks, leaking sewer lines, pet waste, and wildlife waste, can also be investigated using land cover. Additionally, analyzing trends in land cover over time and predicting future land cover scenarios from these trends and existing ordinances and regulations can help inform management efforts aimed at protecting water resources.

Historic & Current Development

Historically, humans were drawn to the Hampton-Seabrook Estuary to benefit from its abundant natural resources and critical ecological services. Dating back 4,000 years, **Native Americans** relied on the estuary for its rich shellfish and finfish populations, as well as its fertile land for farming. By the 17th century, **European settlers** utilized the estuary for food, both for farming and fish/shellfish harvesting. Infrastructure such as sawmills, windmills, grists, fulling mills, and dams were built along the rivers and creeks within the estuary's watershed to harness energy from wind and water. As more people settled in the area over the centuries, the New Hampshire seacoast became a hub for travelers as taverns and meat shops were erected and roads and bridges were expanded, with the mile-long bridge spanning over Hampton Harbor and connecting the towns of Hampton and Seabrook built in 1901 (Town of Hampton, NH, 2021). In the **20th century**, the area was rapidly developed, including the Hampton Beach area by the 1930s, which resulted in the destruction of salt marsh and dune habitats and sedimentation of Hampton Harbor, the dredging of which continues to present day (Eberhardt & Burdick, 2008). Commercial and residential development along the U.S. Route 1 corridor brought to the area antique stores, restaurants, automobile dealers, and retail stores.

In this century, based on an assessment performed in 2000 for the New Hampshire portion of the watershed, roughly a quarter of the watershed was developed, with 5,800 acres of urban area (23%), 400 acres of cleared land (2%), and 380 acres of disturbed land (2%) (Jones, 2000). There was also a moderate amount of agriculture in the watershed, covering 2,039 acres (8%) (Jones, 2000). The remaining two-thirds of the watershed area consisted of forested and natural lands, with 10,094 acres of forest (40%), 5,392 acres of wetland (21%), and 1,030 acres of open water (4%) (Jones, 2000). Updated land cover data for the entire watershed (both New Hampshire and Massachusetts) was generated in 2015/2016 (Figure 8) and shows **developed land** at 9,157 acres (**31%**), **agricultural land** at 1,294 acres (**4%**), and **natural land** such as forest, meadow, wetlands, and open water at 18,676 acres (**64%**). Because of technological improvements in aerial image capture and analysis between the 2000 and 2015/2016 assessments, it is difficult to directly compare changes in major land use types.

The land immediately surrounding the estuary and salt marsh is highly developed with residences, commercial businesses, roads, and other impervious surfaces, and development in the watershed and around the estuary continues. **From 2000 to 2015, 847 new housing units were added in Hampton**

and 183 were added in Hampton Falls. In the region at large, the number of new building permits issued each year decreased from 2000-2010 but has remained stable from 2010-2015 at roughly 400 new permits per year for single-family units and 300 new permits per year for multi-family units (PREP, 2018). **The towns of Hampton and Seabrook are densely populated** at 1,089 and 929 persons per square mile, respectively (Town of Hampton, NH, 2021; Town of Seabrook, NH, 2011). The Town of Hampton contains 122 miles of road, with 37 miles of road within the Urban Compact Area and 25 bridges monitored by the NHDOT, of which two are red-listed by the state (Town of Hampton, NH, 2021). The **area of impervious surfaces (buildings and roads) in the Town of Seabrook nearly doubled from 1990 to 2005**, growing from 802 acres (14%) to 1,539 acres (27%); these impervious surfaces replaced woodlands, agricultural fields, wetlands, and wildlife habitat (Town of Seabrook, NH, 2011).

Significant industries in the watershed include energy generation, metal fabrication, entertainment, and the manufacturing of textiles, plastics, shoes, and furniture (Jones, 2000). Two of the largest employers in the region are **Foss Performance Materials** (textile manufacturing) and the **Hampton Beach Casino** (entertainment) (Town of Hampton, NH, 2021). The **NextEra Energy Seabrook Station** is a 1,220-megawatt nuclear reactor located 2 miles inland from the coastline along the western side of the estuary between Browns River and Hunts Island Creek (Nash & Dejadon, 2019; Jones, 2000). It is the largest source of energy in New England, and in 2019, it produced approximately 61% of New Hampshire's net electrical generation (Town of Hampton, NH, 2021). It originally had its own wastewater treatment facility (WWTF), but by 1994, the station's effluent was diverted to the Seabrook WWTF.

Pollutant Sources

<u>Nonpoint Source Pollution</u>

Diffuse sources of NPS pollution to surface waters can come from contaminants transported in overland flow, groundwater flow, or direct deposition. Examples of NPS pollution include stormwater runoff, erosion, malfunctioning septic systems, leaky sewer lines, excessive fertilizer application, unmitigated agricultural activities, pet waste, and nuisance wildlife waste, each of which are addressed below.

Stormwater Runoff

The dense residential and commercial development in the Hampton-Seabrook Estuary watershed has generated a multitude of potential pollutant sources impacting the physical, chemical, and biological integrity of the estuary and its supporting landscapes. The 2018 *State of Our Estuaries Report* **identified increasing impervious cover as a significant pressure indicator** for the Hampton-Seabrook Estuary watershed (PREP, 2018). The towns of Hampton and Seabrook each have greater than 15% impervious cover, while Hampton Falls has between 5-10%. In particular, the Town of Seabrook has one of the highest percentages of impervious cover (at 20%) in the seacoast region and has experienced one of the largest increases in impervious cover between 2010 and 2015 (at 64 acres). Because of this, the **Town of Seabrook has made great progress in reducing impervious cover** (refer to the Management Strategies section). PREP (2018) also identified TSS and nutrient loading as two other cautionary pressure indicators for the Hampton-Seabrook Estuary watershed. Increases in TSS and nutrient loading are linked to land use change as forested land is converted to developed land, particularly impervious cover.

Impervious cover includes areas with asphalt, concrete, compacted gravel, and rooftops **that force rain and snow** that would otherwise soak into the ground **to run off as stormwater**. High volumes of stormwater runoff can generate erosion in areas with exposed soil, particularly construction sites or high traffic areas. As a result, **stormwater runoff carries pollutants to waterbodies** that may be harmful to aquatic life, including sediments, nutrients, pathogens, pesticides, hydrocarbons, metals, PCBs, and DDT. These contaminants from historic tanneries, landfills, and petroleum processing facilities, as well as current residential, commercial, and industrial activities, in the watershed enter the estuary and settle into bottom sediments. Samples from tidal creeks, rivers, and intermittent streams have shown detectable levels of contamination and high levels of fecal indicator bacteria counts (Nash & Dejadon, 2019).

Erosion

Erosion can occur when the ground is disturbed by digging, construction, plowing, foot or vehicle traffic, or wildlife. Rain and associated runoff are the primary pathways by which eroded soil reaches surface waters. Once in surface waters, nutrients and other pollutants are released from the soil particles into the water column, causing excess pollutant loading to surface waters or cultural eutrophication. Since development demand near water is high, **construction activities** can be a large source of nutrients to surface waters. **Unpaved roads and trails** used by motorized vehicles near surface waters are especially vulnerable to erosion. **Stream bank erosion** can also have a rapid and severe effect on water quality and can be triggered or worsened by upstream impervious surfaces such as buildings, parking lots, and roads which send large amounts of high velocity runoff to surface waters. Maintaining natural vegetative buffers around surface waters and employing strict erosion and sedimentation controls for construction can minimize these effects.

Soil erosion hazard is dependent on a combination of factors, including land contours, climate conditions, soil texture, soil composition, permeability, and soil structure (O'Geen, Elkins, & Lewis, 2006). Soil erosion hazard should be a primary factor in determining the rate and placement of development within a watershed. Soils with negligible soil erosion hazard are primarily low-lying wetland areas, which are sensitive to development for other reasons aside from native soil erosion hazard ratings. The soil erosion hazard for the Hampton-Seabrook Estuary watershed was determined from the associated slope and soil erosion factor Kw[1] used in the Universal Soil Loss Equation (USLE). The USLE predicts the rate of soil loss by sheet or rill erosion in units of tons per acre per year. A rating of “slight” specifies erosion is unlikely to occur under standard conditions. A rating of “moderate” specifies some erosion is likely and erosion-control measures may be required. A rating of “severe” specifies erosion is very likely and erosion-control measures and revegetation efforts are crucial. A rating of “very severe” specifies significant erosion is likely and control measures may be costly. **“Severe” erosion hazard areas account for 5% of the watershed and are mostly concentrated in the upland headwater (steeper) portions of the watershed** (Figure 9). Moderate erosion hazard areas account for 37% of the watershed. Slight erosion hazard areas account for 44% and are concentrated in low-lying areas around the estuary. Over 13% of the watershed is not rated. Development should be restricted in areas with severe and very severe erosion hazards due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss. Since a highly erodible soil can have greater negative impact on water quality, more effort and investment are required to maintain its stability and function within the landscape, particularly from controls that protect steep slopes from development and/or prevent stormwater runoff from reaching water resources.

[1] K_w = the whole soil k factor. This factor includes both fine-earth soil fraction and large rock fragments.

Wastewater

Untreated discharges of sewage (domestic wastewater) are prohibited regardless of source. An example of an illicit discharge of untreated wastewater is from **insufficient or malfunctioning subsurface sewage treatment and disposal systems, commonly referred to as septic systems**, but which also include holding tanks and cesspools, as well as leaky or blocked sewer lines. When properly designed, installed, operated, and maintained, septic systems can reduce nutrient and pathogen concentrations in sewage within a zone close to the system (depending on the development and maintenance of an effective biomat, the adsorption capacity of the underlying native soils, and proximity to a restrictive layer or groundwater). **Age, overloading, or poor maintenance can result in system failure and the release of nutrients, pathogens, and other pollutants**, such as microplastics and pharmaceuticals, into surface waters (EPA, 2016). Pollutants from insufficient septic systems or leaky or blocked sewer lines can enter surface waters through surface overflow or breakout, stormwater runoff, or groundwater. Cesspools are buried concrete structures that allow solid sludge to sink to the bottom and surface scum to rise to the top and eventually leak out into surrounding soils through holes at the top of the structure. Holding tanks are completely enclosed structures that must be pumped regularly to prevent effluent back-up into the home.

Residential, commercial, and industrial areas in the Hampton-Seabrook Estuary watershed are serviced by either municipal sewer or private septic systems. A small survey of 90 properties around the estuary showed 75% served by municipal sewer (Nash & Dejadon, 2019). **Aging sewer infrastructure in the towns have caused untreated sewage discharge to surface and groundwater in the watershed**. In 2015-2016, a 14-inch sewer force main buried eight feet under the salt marsh in Hampton between the Church Street pumping station and the Hampton WWTF ruptured and discharged raw sewage to the estuary. The Town of Hampton has since begun “planning for the eventual abandonment of the two lines buried under the marsh and replacing them with two new lines that would be located along Route 101” (Nash & Dejadon, 2019). The Church Street force main through the salt marsh was permanently decommissioned in 2018. A 20-gallon sewage discharge from an overflowing manhole in a commercial retail store parking lot along U.S. Route 1 in Seabrook was reported in 2017. Three sewage discharges totaling no more than 50 gallons from private systems, one sewage discharge of an undetermined amount from a disconnected sewer line to a private trailer, and one sewage discharge totaling 2,000 gallons from a blocked sewer line were reported in Seabrook in 2016. One sewage discharge from a blocked sewer line along U.S. Route 1 was reported in Hampton in 2016. None of these discharges were reported as impacting surface waters (Nash & Dejadon, 2019).

Residential or Commercial Fertilizer Use

When lawn and garden fertilizers are applied in excessive amounts, too close to a waterbody, in the wrong season, or just before heavy precipitation, they can be transported by rain or snowmelt runoff to surface waters where they can promote cultural eutrophication and impair the recreational and aquatic life uses of the waterbody. Many states and local communities are beginning to set restrictions on the use of fertilizers by prohibiting their use altogether or requiring soil tests to demonstrate a need for any phosphate application to lawns.

Agricultural Practices

Although agriculture is less prominent in the watershed today, runoff from agricultural fields containing manure and fertilizer are also potential sources of pollutants to the estuary. Diffuse runoff of farm animal waste from land surfaces (whether from manure stockpiles or cropland where manure is spread), as well as direct deposition of fecal matter from farm animals standing or swimming in surface waters, are significant sources of agricultural nutrient pollution in surface waters. Farm activities like plowing, livestock grazing, vegetation clearing, and vehicle traffic can also result in soil erosion which can contribute to nutrient pollution. Excessive or ill-timed application of manure or crop fertilizer or poor manure storage which allows nutrients to wash away with precipitation not only endangers surface waters but also means those nutrients are not reaching the intended crop. The key to nutrient application is to apply the right amount of nutrients at the right time. When appropriately applied to soil, synthetic fertilizers or animal manure can fertilize crops and restore nutrients to the land. When improperly managed, pollutants in manure can enter surface waters through several pathways, including surface runoff and erosion, direct discharges to surface water, spills and other dry-weather discharges, and leaching into soil and groundwater.

Pet Waste

In residential or public recreation areas, fecal matter from pets can be a significant contributor of nutrients and pathogens to surface waters. Each dog is estimated to produce 200 grams of feces per day, which contain concentrated amounts of nutrients and pathogens (CWP, 1999). If pet feces are not disposed of properly, these nutrients can be washed off the land and transported to surface waters by stormwater runoff. Pet feces can also enter surface waters by direct deposition of fecal matter from pets standing or swimming in surface waters.

Nuisance Wildlife Waste

Fecal matter from wildlife such as geese, gulls, other birds, and beaver may be a significant source of nutrients in some watersheds. This is particularly true when human activities, including the direct and indirect feeding of wildlife and habitat modification, result in the congregation of wildlife (CWP, 1999). Congregations of geese, gulls, and ducks are of concern because they often deposit their fecal matter next to or directly into surface waters. Examples include mowed fields adjacent to surface waters where geese and other waterfowl gather, as well as the underside of bridges with pipes or joists directly over the water that attract large numbers of pigeons or other birds. Studies show that geese inhabiting riparian areas increase soil nitrogen availability (Choi, et al., 2020) and gulls along shorelines increase phosphorus concentration in beach sand pore water that then enters surface waters through groundwater transport and wave action (Staley, He, Shum, Vender, & Edge, 2018). When submerged in water, the droppings from geese and gulls quickly release nitrogen and phosphorus into the water column, contributing to eutrophication in freshwater ecosystems (Mariash, Rautio, Mallory, & Smith, 2019). On a global scale, fluxes of nitrogen and phosphorus from seabird populations have been estimated at 591 Gg N per year and 99 Gg P per year, respectively (with the highest values derived from arctic and southern shorelines) (Otero, De La Peña-Lastra, Pérez-Alberti, Osorio Ferreira, & Huerta-Diaz, 2018). Additionally, other studies show greater concentrations of nitrogen, ammonia, and dissolved organic carbon downstream of beaver impoundments when compared to similar streams with no beaver activity in New England (Bledzki, Bubier, Moulton, & Kyker-Snowman, 2010).

<u>Point Source Pollution</u>

Point source pollution can be traced back to a specific source such as a discharge pipe from an industrial facility, municipal treatment plant, permitted stormwater outfall, or a regulated animal feeding operation, making this type of pollution relatively easy to identify. Section 402 of the CWA requires all such discharges to be regulated under the NPDES program to control the type and quantity of pollutants discharged. NPDES is the national program for regulating point sources through issuance of permit limitations specifying monitoring, reporting, and other requirements under Sections 307, 318, 402, and 405 of the CWA.

NHDES operates and maintains the OneStop database and data mapper, which houses data on Potential Contamination Sources (PCS) within the State of New Hampshire. Identifying the types and locations of PCS within the watershed may help identify sources of pollution and areas to target for restoration efforts. Downloaded and filtered for the Hampton-Seabrook Estuary watershed, these data identify potential sources of pollution to the estuary, including aboveground storage tanks, underground storage tanks, automobile salvage yards, solid waste facilities, hazardous waste sites, local potential contamination sources, NPDES outfalls, and remediation sites (Figure 10).

Above and Underground Storage Tanks

Above and underground storage tanks include permitted containers with oil and hazardous substances such as motor fuels, heating oils, lubricating oils, and other petroleum and petroleum-contaminated liquids. There are **30 aboveground storage tanks** within the watershed. Twenty-four (24) are found in Seabrook, five in Hampton, and one in North Hampton at commercial (Lowe's, Yankee Greyhound Racing, Inc., Jiffy Lube, First Student, Inc.), industrial (Foss Manufacturing Co., LLC), municipal (Hampton Department of Public Works, Seabrook Fire Department), and utility (NextEra Energy Seabrook Station) properties. There are **139 underground storage tanks** within the watershed. Sixty-nine (69) are found in Hampton, 56 in Seabrook, 11 in Hampton Falls, two in North Hampton, and one in Exeter at various properties[2], as well as at numerous gas stations. The Yankee Fisherman's Cooperative, which is a group of fishermen who work together to provide dock facilities, fuel, ice, and a place to unload fish, have on-site machinery (hoists), as well as a 10,000-gallon diesel steel aboveground storage tank that sits approximately 180 feet from the water (Nash & Dejadon, 2019). The Hampton Harbor state boat launch provides fuel to fisherman and recreational boaters through their 10,000-gallon diesel underground storage tank and 4,000-gallon gasoline underground storage tank (Nash & Dejadon, 2019).

Automobile Salvage Yards

There are **three automobile salvage yards** within the watershed that either contain at least 12 "end-of-life" vehicles annually or at least 25 vehicles for more than 60 days at a time. Foggs Auto Recycling, Circle Motor Sales, and Walter E. Knowles Auto Salvage, all located in Seabrook, are currently registered with the NHDES Greenyards Program as active.

Solid Waste Facilities

There are **eight solid waste facilities** within the watershed. Two facilities currently in operation for the collection, storage, and transfer of waste are the Hampton and Seabrook transfer stations. There is one abandoned dump/brush and stump dump classified as an unlined landfill in Hampton Falls. There are

[2] …commercial (Scott Pontiac, Ames Department Store, Captains Quarters, First Student, Inc., Former J R Murphy Lumber Co., Frank Fitzgerald, Inc., GMS Excavating, Gaslight Trust, Hampton Sports Club, John W & Carol K Dodge, One Liberty Hampton, LLC, RAI Resource Analysts, Inc., Wheelabrator Technologies, Inc., Yankee Greyhound Racing, Inc., Hampton River Marina, PS Marston Assoc., Inc., Seacoast Coca Cola Bottling Co.), federal (US Postal Service Hampton), industrial (Benoit Development Co., Chemtan Co., Inc., D.G. O'Brien, Inc., DDR Seabrook, Foss Manufacturing Co., Inc., Henkel Technologies, Spherex, The Timberland Co.), residential or agricultural, municipal (Centre School, Hampton Department of Public Works, Hampton Academy Jr High School, Lane Memorial Library, Lincoln Akerman School, Marston School, Seabrook Elementary/Middle School, Seabrook Fire Department, Winnacunnet High School), state (Hampton Turnpikes PS 830), and utility (Bell Atlantic, NextEra Energy Seabrook Station, Verizon) properties.

four close, unlined municipal landfills in Hampton Falls, Hampton, Kensington, and Seabrook. One inactive processing and treatment facility, North Atlantic Energy, is in Seabrook.

Hazardous Waste Sites

Hazardous waste generating facilities are identified through the EPA's Resource Conservation and Recovery Act (RCRA) and require either federal or state regulation. Only 50 of the **173 hazardous waste generating facilities** within the watershed are listed as active; the remaining facilities are classified as either inactive (87), declassified (33), unspecified (2), or non-notifier (1). Seventy-nine (79) are found in Seabrook, 79 in Stratham, 69 in Hampton, 11 in Hampton Falls, seven in North Hampton, five in Kensington, and one in Exeter. The facilities include a range of commercial and industrial operations such as automotive and trucking, steelworks, pharmacies, demolition, cleaners, gas stations, medical and veterinary facilities, retail stores, utilities, machinery, and breweries.

Local Potential Contamination Sources

Local PCS are sites that may represent a hazard to drinking water quality supplies due to the use, handling, or storage of hazardous substances. There may be overlap between local PCS and other PCS identified in this section. Of the **83 local PCS** within the watershed, 35 are found in Seabrook, 22 in Hampton Falls, 18 in Hampton, five in North Hampton, and three in Kensington. Local PCS include salons, dry cleaners, pool stores, barber shops, salvage areas, auto repair shops, business condos, machine shops, fabrication, chrome plating companies, leather finishing, butchers, medical and veterinary facilities, antique shops, auto repair shops, car washes, and retail shops.

NPDES Outfalls

Of the **11 NPDES outfalls** that discharge pollutants directly to surface waters within the watershed, six are actively discharging: Chemtan Co., Inc. (NHG250121) discharges non-contact cooling water, which is non-toxic, so no dilution factor is needed, to Ash Brook in Exeter; NHDOT (NH0022225) and Gruhn Engine Repair Site (NHG910007) are classified in the groundwater category and discharge to a wetland to the Taylor and Hampton Falls rivers, respectively; Aquatic Research Organisms (NH0022985) and Enthalpy, Inc. (formerly EnviroSystems, Inc.) (NH0022055) discharge wastewater through a shared outfall to the Taylor River and require a dilution of 100; the Hampton WWTF (NH0100625) provides secondary wastewater treatment and discharges wastewater directly to the estuary via a tributary to Tide Mill Creek with no dilution. Secondary WWTFs remove most bacteria and suspended particles from the water but do not filter the water to remove nutrients (EPA, 2022a).

The average sewage flow to the **Hampton WWTF** is 2.6 million gallons per day. Nash & Dejadon (2019) indicate that the Hampton WWTF is likely the most significant source of pollution to the estuary; however, NHDES found no significant deficiencies in the Hampton WWTF related to "effluent bacteria concentration, plant flow levels, or operation of the disinfection system" (Nash & Dejadon, 2019). Effluent bacteria concentrations tend to be highest in the spring and summer during peak tourism. The Town of Hampton is currently in phase one of three to replace and improve the Hampton WWTF and associated sewer infrastructure (Town of Hampton, NH, 2021).

The **Seabrook WWTF** (NH0101303) provides secondary treatment to wastewater for most residences and businesses in Seabrook and outfalls directly to the Atlantic Ocean approximately 2,100 feet offshore of Seabrook Beach (Nash & Dejadon, 2019). NHDES flow studies indicate that the estuary is not impacted by effluent discharge by the Seabrook WWTF; however, the sewer infrastructure in Seabrook near the estuary is of greater concern for risk to water quality (Nash & Dejadon, 2019). PREP (2018) listed the pressure indicator, point source nutrient loading from WWTFs, as improving for the Seabrook and Hampton WWTFs in the Hampton-Seabrook Estuary watershed. The improving rating is due to ongoing upgrades to the WWTFs.

Remediation Sites

The 314 remediation sites present within the watershed consist of leaking storage facilities that contain fuel or oil, initial spill response sites, historical dump sites, leaking residential or commercial oil tanks for heating or motor oil tanks, underground injection control of wastewaters not requiring a groundwater discharge permit, discharge of hazardous fluids and fuel from sunken boats or cars, stormwater runoff from businesses such as an auto garage, or a flagged groundwater sample for contamination but with no direct connection to a source of contamination. Of the **314 remediation sites**, 131 are found in Seabrook, 120 in Hampton, 40 in Hampton Falls, eight in Exeter, eight in Kensington, six in North Hampton, and one in Stratham.

Air Facility Systems

There are **three active air facility systems** in the watershed: NextEra Energy Seabrook, LLC in Seabrook, Foss Performance Materials, LLC in Hampton, and Foss Manufacturing Co., LLC in Hampton.

Hampton Harbor. © Marinas.com

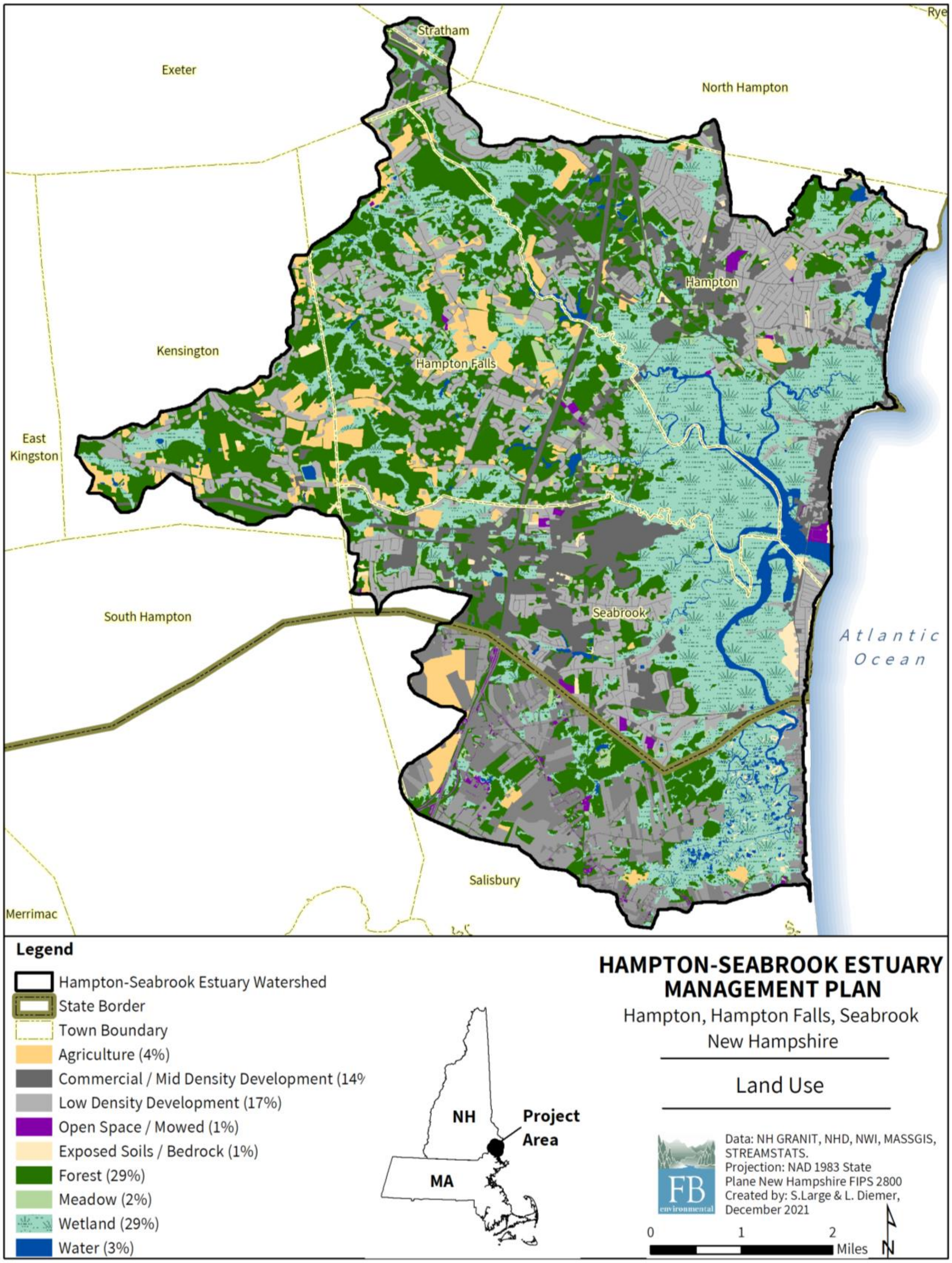


Figure 8. *Land use in the Hampton-Seabrook Estuary watershed. Land use data obtained from NH GRANIT's Land Use 2015 – Southeastern New Hampshire dataset and MassGIS' Land Use 2016 dataset.*

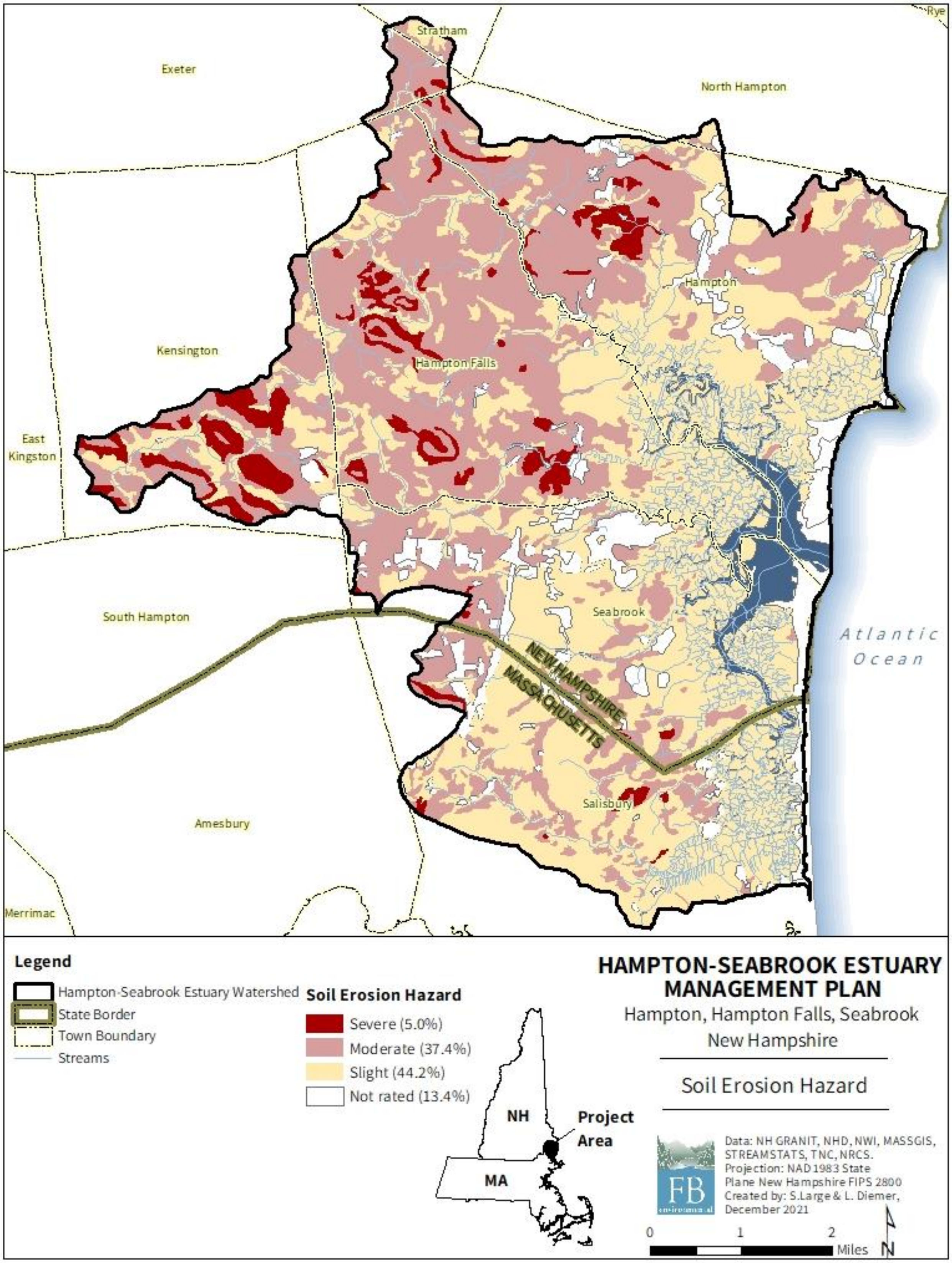


Figure 9. *Soil erosion hazard for the Hampton-Seabrook Estuary watershed.*

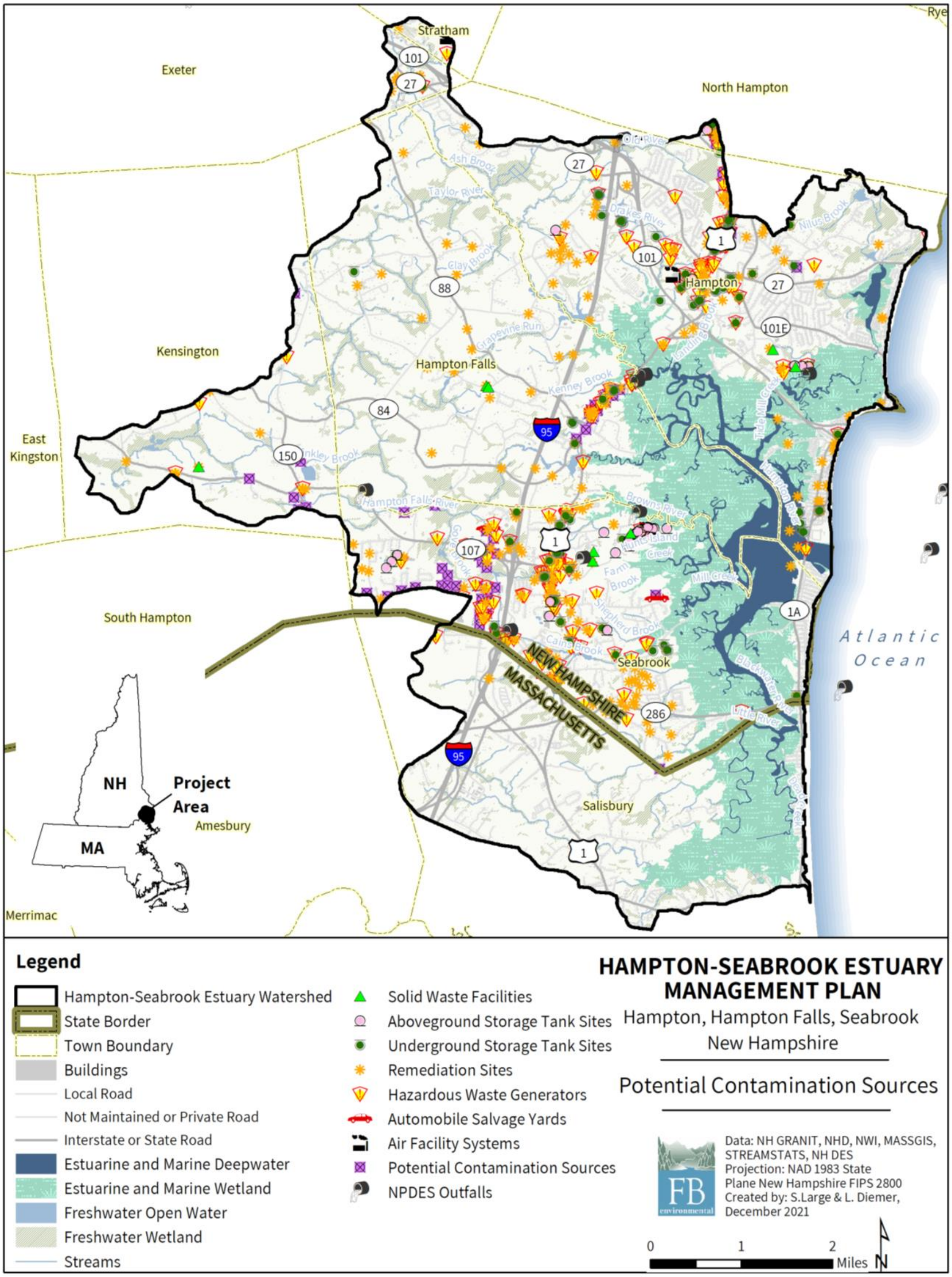


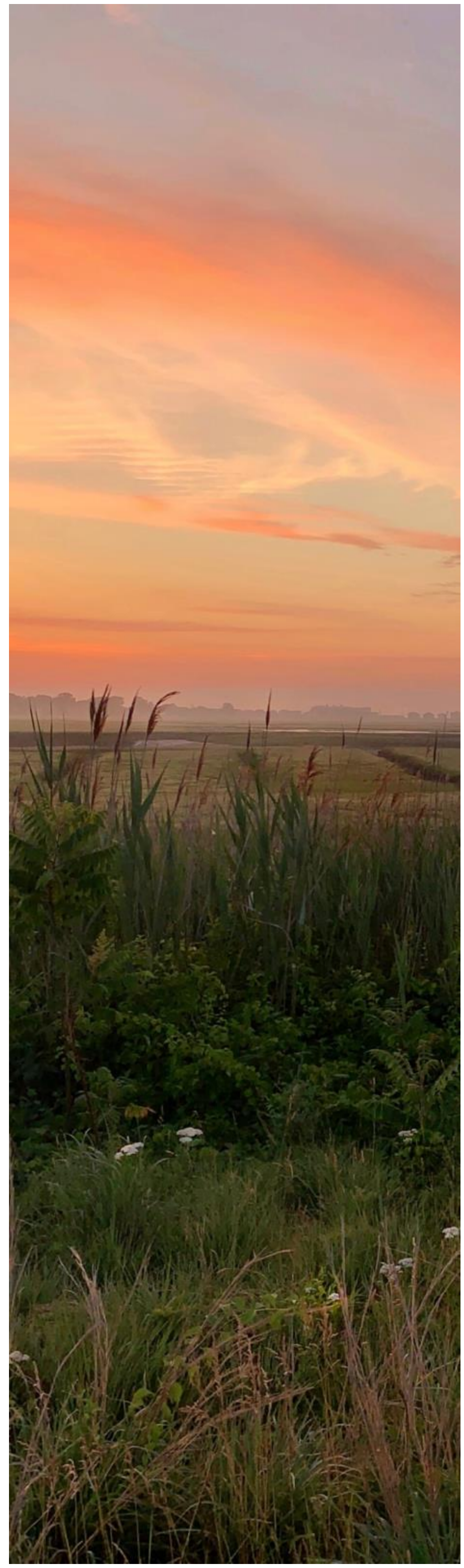
Figure 10. *Location of potential contamination sources in the Hampton-Seabrook Estuary watershed.*

Conservation Areas

The Hampton-Seabrook Estuary watershed contains **2,883 acres (10%) of permanently conserved land** across the towns of Hampton, Hampton Falls, Seabrook, and Salisbury (Figure 11). Much of the conserved land in the watershed is located adjacent to or contains critical natural resources such as the Hampton-Seabrook Marsh, Meadow Pond, Muddy Pond, Ash Brook, and the Taylor and Hampton Falls rivers. As of 2006, 346 acres of the Hampton-Seabrook Marsh were permanently protected and managed as natural areas or ecological reserves, 518 acres were permanently protected as working forest, 75 acres were in public or institutional ownership but were not permanently protected, and 10 acres were managed for the primary use of extracting natural resources (Zankel, et al., 2006). Today, **897 acres (12%) of the Hampton-Seabrook Marsh, representing 7,438 acres** (Zankel, et al., 2006)**, are permanently conserved** land in the watershed.

Smaller conservation areas also exist in other areas of the watershed towns. In Hampton, notable conserved lands in addition to the Hampton-Seabrook Marsh include the Town Forest (also known as White's Lane or Twelve Share area), Hurd Farm, Batchelder Farm, Ice Pond, Car Barn Pond, and the Barkley property. Both Hurd Farm and Batchelder Farm are protected under easement and are composed of agricultural land, forest, and wetlands that protect water quality and provide recreational opportunities. The Town Forest, Ice Pond, Car Barn Pond, and the Barkley property are owned by the Town of Hampton (Town of Hampton, NH, 2022). In Hampton Falls, notable conserved lands include Raspberry Farm and the Janvrin Natural Area adjacent to Raspberry Farm, the Marsh Lane Conservation Preservation and Extension, Depot Road Scenic Vista, and Niebling Tree Farm. In Seabrook, notable conserved lands include Grace C. Fogg Wildlife Preserve and the Seabrook Back Dunes. Many of these conserved lands are utilized for passive recreation.

Conserving land protects more than the land itself, it ensures clean water, supports common and rare wildlife and plant populations, minimizes flood damage, safeguards recreational opportunities, and prepares the region for the changes it is already experiencing from climate change. **The conservation goal for the Piscataqua Region is for 20% of all land to be conserved**, which as of 2017 stands at just over 15% after 41,555 acres of conserved lands were newly protected between 2011-2017 (PREP, 2018). As of 2022, both Hampton and Seabrook had



Sunset over the Hampton-Seabrook Estuary. © Carolyn Castiglioni.

less than 10% of land protected (7% in the watershed) and Hampton Falls had less than 15% (12% in the watershed). To restore the health of the estuary and prepare for future challenges from development and climate change, **more land conservation in the watershed is needed**.

Areas for land conservation can be prioritized based on the presence of critical natural resources and habitats. Much work has already been done to identify these critical areas in need of conservation in the seacoast region. In 2006, TNC, the Society for the Protection of New Hampshire Forests, the RPC, and the Strafford Region Planning Commission (SRPC) developed the ***Land Conservation Plan for New Hampshire's Coastal Watersheds*** (Zankel, et al., 2006), which identified conservation focus areas (CFAs) representing the most critical coastal natural resources in need of protection, encompassing much of the wildlife habitat protection priorities identified later in the ***New Hampshire Wildlife Action Plan*** (NHFG, 2015). NHFG ranks habitat based on value to the state, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape for the protection of Species of Greatest Conservation Need in New Hampshire. The Hampton-Seabrook Estuary watershed is part of the Gulf of Maine Coastal Plain Lowland ecoregional subsection of the biological region (NHFG, 2015). About 72% of the *Land Conservation Plan's* CFAs are also Tier 1 or Tier 2 *Wildlife Action Plan* (WAP) priorities representing highest ranked habitats (Steckler & Brickner-Wood, 2019). Although covering slightly different areas in some portions of the watershed, both CFAs and WAP Tiers 1-3 cover 10,271 acres or 35% of the watershed (Figure 11). In 2016, as a supplement to the 2006 *Land Conservation Plan*, the ***Land Conservation Priorities for the Protection of Coastal Water Resources*** (Steckler, Glode, & Flanagan, Land Conservation Priorities for the Protection of Coastal Water Resources: A Supplement to The Land Conservation Plan for New Hampshire's Coastal Watersheds, 2016) generated water resource overlays identifying focus areas for pollutant attenuation, flood storage and risk mitigation, public water supply, and single and multi-benefit water resources in the seacoast region. In 2019, TNC, in partnership with the Great Bay Resource Protection Partnership, developed ***Connect THE Coast***, which identified critical habitat corridors linking habitat blocks across the seacoast region to protect connective habitats from increasing landscape fragmentation (Steckler & Brickner-Wood, 2019). Over 2,422 acres of habitat corridors, representing additional land linking CFAs, were identified in the watershed. All these conservation prioritization efforts except for the WAP are watershed-based and thus extend into Massachusetts, which is important since Massachusetts does not recognize the Hampton-Seabrook Estuary as part of the state's Areas of Critical Environmental Concern (ACEC). As an update to Zankel et al. (2006), TNC developed the ***New Hampshire's Coastal Watershed Conservation Plan 2021 Update*** (Steckler & Ormiston, 2021).

One of **the most significant CFAs in the seacoast region is the Hampton-Seabrook Estuary** because it consists of unfragmented natural space with a range of wetlands (salt marsh, mudflat, ponds, creeks, and rivers) that are biologically diverse in both species and stratum. Resources provided by the estuary include habitat for common and rare wildlife species, high yield aquifers, drinking water wells, water protection zones, and identified farmland of importance. Beyond the estuary and its salt marsh, land elsewhere in the watershed is also critical to protect. The upland forests, shrublands, fields, freshwater wetlands, rivers, streams, and ponds are resources that are all important for the health and function of the natural resources in the watershed, as well as the surrounding coastal communities. Three other CFAs identified within the watershed are the Taylor River and the Cove, Upper Taylor River, and Muddy Pond CFAs (Figure 11). **The conservation goal for the Piscataqua Region is for 75% of all CFAs to be conserved, which as of 2017 stands at 25-50% for the Hampton-Seabrook Estuary** (PREP, 2018).

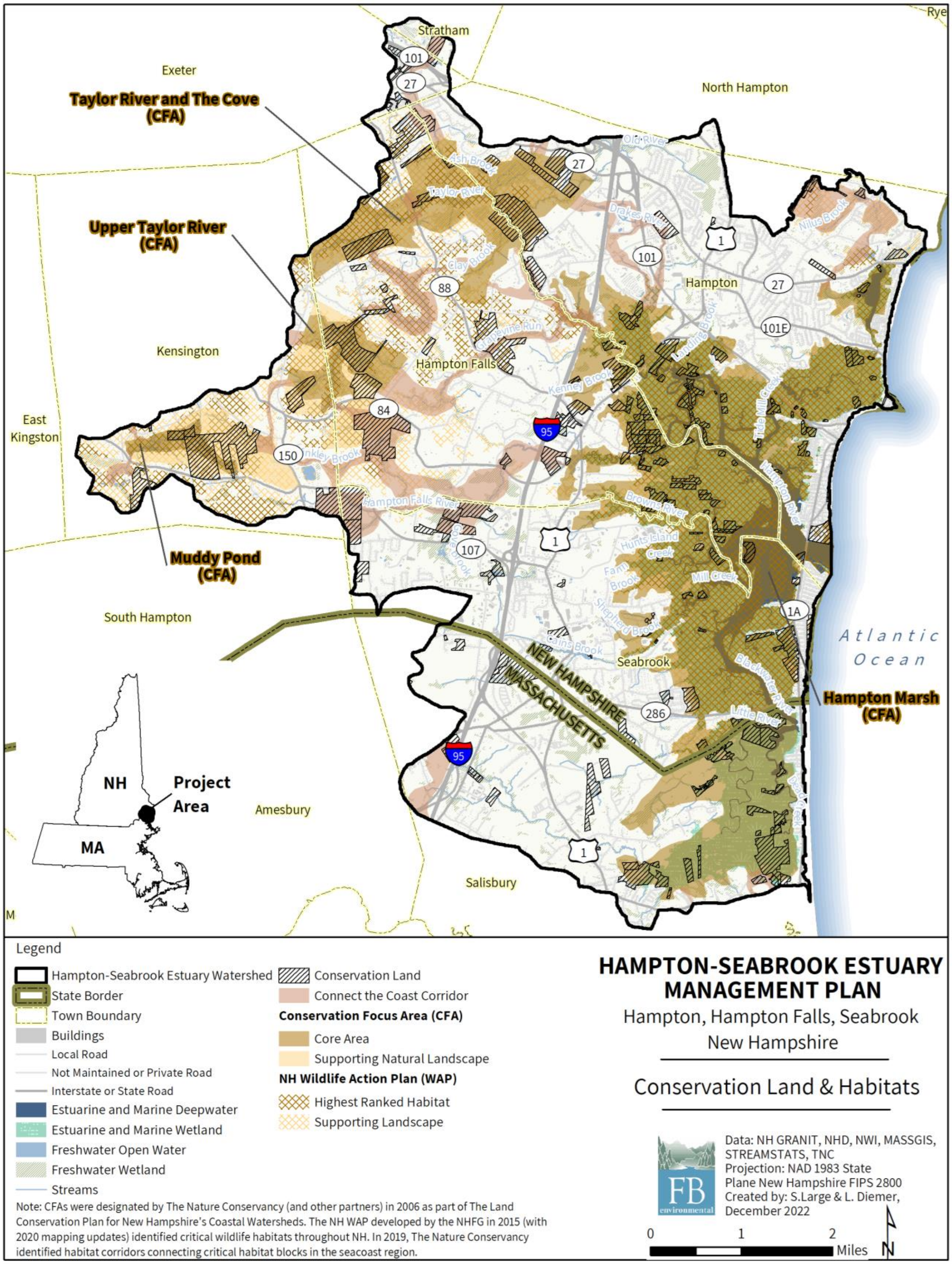


Figure 11. *Conservation land and critical habitats in the Hampton-Seabrook Estuary watershed.*

Fish, Birds, & Other Wildlife

The Hampton-Seabrook Estuary, including its salt marsh and sand dune habitats, supports a rich diversity of plant and wildlife species, several of which are almost exclusively found in and around the estuary. Although there are numerous plants and animals that utilize the estuary for food and habitat, there are a few species that are critical for the ecosystem to function properly and therefore serve as indicators for its overall health. Some of these **key indicator organisms for the Hampton-Seabrook Estuary include diadromous fish, clams and other shellfish, and birds**. When the populations of these key organisms are impacted by various stressors, there is a cascading effect on other plants and wildlife in the estuary. As a result, it is important to routinely monitor these indicators so that threats to the health of the estuary can be detected and tracked over time. This section focuses on fish and shorebird populations; shellfish are discussed in the following section on Shellfish & Harvesting.

Fish

Historically, the seven main rivers within the Hampton-Seabrook Estuary watershed **supported large populations of diadromous fish**, which migrate between fresh and salt water to complete their life cycles. Common to the Hampton-Seabrook Estuary, river herring (alewife and blueback herring), American shad, rainbow smelt, Atlantic salmon, Atlantic sturgeon, rainbow smelt, and sea lamprey live most of their life in saltwater but travel into estuaries and freshwater streams to reproduce (known as anadromous fish). Conversely, the American eel, another historically common species within the estuary, lives most of its life in freshwater and migrates to the sea to spawn (known as **catadromous fish**). Migratory (diadromous) fish are good indicators of water quality, highlighting barriers within waterways and stressors associated with development. Low dissolved oxygen linked to excessive nutrients or impounded, slow-moving water behind dams and undersized culverts under roads; rising water temperatures; and fluctuations in water level due to intense spring floods and summer droughts are all factors that impact populations of migrating fish. More specifically, dissolved oxygen levels of 5 mg/L or less have been shown to alter the behavior of juvenile salmonids, shad, and river herring, with increased fish mortality at dissolved oxygen levels of 3 mg/L or less (Eberhardt & Burdick, 2008). For migratory fish, whose condition was listed as cautionary in the 2018 *State of Our Estuaries Report*, **populations of river herring within the Taylor River have decreased dramatically in recent years despite rebounding within Great Bay**; this decrease is likely caused by poor water quality in upstream impoundments (PREP, 2018). The decline in mosquito populations following historic salt marsh ditching has also been linked to a **decline in small fish populations in the estuary** (Eberhardt & Burdick, 2008). Non-diadromous fish found in the brackish or freshwater portions of the watershed include banded sunfish, bridle shiner, eastern brook trout, redfin pickerel, shortnose sturgeon, smooth and winter flounder, white perch, and hake (NHFG, 2015).

Despite having toxicity data to assess the safety of fish consumption in all surface waters, there is minimal data on other fish population metrics within the Hampton-Seabrook Estuary watershed. In the NHDES EMD, fish population data are only available for two waterbodies in the watershed: Taylor River Refuge Pond (NHLAK600031003-02) and Hampton Falls River-Winkley Brook (NHRIV600031003-01). Taylor River Refuge Pond was surveyed for fish populations in 2007 as part of a NHDES study, which found 12 brown bullheads with an average weight of 232 g and an average length of 24 cm and 12 largemouth bass with an average weight of 258 g and an average length of 27 cm. Hampton Falls River-Winkley Brook was surveyed in 1984 for fish populations as part of a NHFG study, which found one

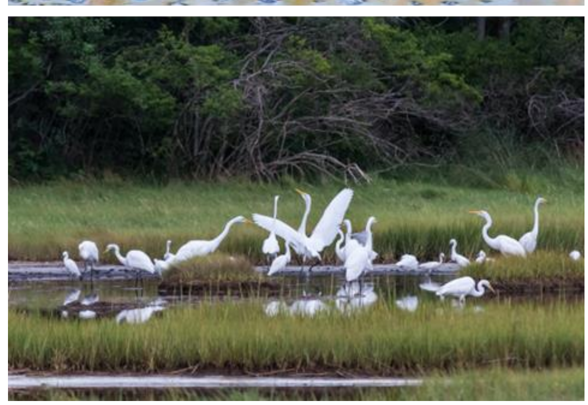
American eel, two common sunfish, five eastern brook trout, one eastern chain pickerel, and one redfin pickerel. See Table S1 in the HSE EMP Supplementary Document.

Birds

The Hampton-Seabrook Estuary is considered a significant migratory stopover site for shorebirds due to the diversity and abundance of birds that utilize the estuary's habitats for foraging and breeding. Approximately **3,000-3,500 shorebirds made up of over 20 species regularly pass through the estuary** during their southbound migration in the fall (McKinley & Hunt, 2008). Although the estuary is primarily used for southward migration, it also serves as a vital link in the northward migration of shorebirds. Most **shorebirds** utilizing the estuary are the semipalmated plover and semipalmated sandpipers, along with the black-bellied plover and greater yellowlegs (Hunt, 2020). Other common species include the salt marsh sharp-tailed sparrow and the common tern. Some common **waterfowl** seen throughout the estuary include wood ducks, American black ducks, mallard, common loons, and Canada geese. **Wading birds** found in the area include the great blue heron, green and black-crowned night herons, snowy egrets, and glossy ibis. Many **terrestrial bird species** such as the American crow, belted kingfisher, ruffed grouse, wild turkey, bald eagle, upland sandpiper, marsh hawk, osprey, grey catbird, cedar wax wing, common yellowthroat, eastern phoebe, and tufted titmouse can also be found in or near the estuary (Jones, 2000; McKinley & Hunt, 2008). **Protected birds** within the estuary include the common tern (a state listed species) and the piping plover (a federally listed threatened species) (Town of Seabrook, NH, 2011). Six species of non-breeding sandpipers (whimbrel, ruddy turnstone, sanderling, red knot, purple, and semipalmated) are recognized as Species of Greatest Conservation Need by the NHFG (NHFG, 2015).

Shorebirds preferentially use certain locations within the estuary for different purposes. Foraging activity typically takes place within the extensive mudflats found at the southern end of Hampton Harbor, the mouths of Tide Mill Creek and Browns River, and the freshwater and brackish pools along the northern edge of the estuary



TOP: Sandpiper. © Bri Benvenuti.
MIDDLE TOP: Plover. © Bri Benvenuti.
MIDDLE BOTTOM: Sandpiper. © Matt Parker.
BOTTOM: Egrets. © Matt Parker.

(McKinley & Hunt, 2008). For roosting, shorebirds have been documented using Plaice Cove, Meadow Pond, Hampton Harbor, and Seabrook Beach, with the northeast portion of salt marsh within the estuary used by breeding birds. In surveys completed by the New Hampshire Audubon in 2006-2007 and 2018, researchers found that roosting had decreased within the estuary. This decrease was primarily attributed to increased disturbance from construction, rising waters, and more frequent flooding. For the Hampton-Seabrook Estuary to continue to provide critical bird foraging and breeding habitat, it is important that adequate conservation measures are taken to protect and restore these habitats, including the estuary, salt marsh, and sand dunes (Hunt, 2020).

Other Wildlife

Other wildlife found in the Hampton-Seabrook Estuary and its watershed include various species of amphibians, reptiles, fish, and mammals. Amphibians such as bullfrogs, green frogs, and blue-spotted salamanders can be found in the freshwater reaches of the watershed, along with reptiles like the eastern ribbon and smooth green snakes and Blanding's, eastern painted, snapping, eastern box, spotted, and wood turtles. Mammals found in the estuary's watershed include deer, coyotes, bobcats, gray fox, otters, minks, beavers, bats, and moose. Several bat species found in the watershed include the big brown bat, eastern red bat, hoary bat, little brown bat, northern long-eared bat, silver-haired bat, and the tricolored bat (NHFG, 2015).

Shellfish & Harvesting

Softshell clams (*Mya arenaria*) **and other shellfish**[3], such as blue mussels (*Mytilus edulis*), razor clams (*Siliqua patula*), and surf clams (*Spisula solidissima*), **are key aquatic indicator species** within the Hampton-Seabrook Estuary, signifying the overall health and function of the estuary (Nash & Dejadon, 2019). Although the concentration of polycyclic aromatic hydrocarbons (PAHs) in mussel tissues remain below the national median, there are **emerging contaminants of concern**, including pharmaceuticals, per-fluorinated compounds, and flame retardants, that threaten the health of the estuary's shellfish populations. In 2015, there were 1.4 million adult clams in the estuary, far less than the annual average of 2.4 million from 2009-2011 and the goal of 5.5 million, possibly due to a fatal cancer linked to warming waters and increases in heavy metals and hydrocarbons in water (PREP, 2018). A more recent trend from 2015-2018, however, suggests that the overall density of adult clams has increased (Nash & Dejadon, 2019). Although the population of clams has been cyclical throughout history, there has been a **notable overall decline in clam populations since 1997** in the Hampton-Seabrook Estuary (PREP, 2018). In addition, between 2012 and 2016, the percentage of possible acre-days (i.e., the number of open acres multiplied by the number of days those acres were open for harvest) was 66% for the Hampton-Seabrook Estuary, which continues a long-term gradual increasing trend in acre-days (PREP, 2018). Clam flats are often closed following large (>1") rain events that generate polluted runoff to surface waters. Refer to the Watershed Land Use section for identification and discussion of possible sources of pollution to surface waters.

Softshell clams and blue mussels are recreationally harvested from exposed mudflats within the estuary (Town of Seabrook, NH, 2011) and only from areas that are conditionally approved by NHDES based on acceptable water or tissue data or absence of known or suspected discharge events. Data

[3] Other shellfish that live in the estuary include lobsters, rock crabs, hermit crabs, and snail species. Various species of freshwater mussels can also be found in the watershed, including the creeper mussel, eastern pond mussel, and alewife, brook, and triangle floater mussels (Town of Seabrook, NH, 2011).

regarding the safety of shellfish harvesting and consumption are available in the NHDES *Sanitary Survey Report for Hampton Harbor* (Nash & Dejadon, 2019). There are 17 water quality stations within the harbor where fecal coliform data are collected to evaluate designated areas for shellfish harvesting (Figure 12). From 2015-2018, only one of these stations (HH33) had a geometric mean above the 14 MPN/100mL state criteria to support the designated use of shellfish harvesting (15.3 MPN/100mL), and 10 stations had 90th percentile values above the 43 MPN/100mL state criteria to support the designated use of shellfish harvesting, with concentrations ranging from 49-144 MPN/100 mL (Nash & Dejadon, 2019) (Figure 12). Fecal coliform in the harbor is highly seasonal, with concentrations averaging around 5 MPN/100mL during the winter and spring and 17-20 MPN/100mL during the summer and fall from 2009-2018 (Nash & Dejadon, 2019). As such, the start of the clamming season in Hampton Harbor is typically delayed until November and continues through May**; seasonal closures due to unpredictable fecal indicator bacteria levels and boat sewage contamination typically occur each year from June to October**. Eight of the 17 stations are located in areas classified as conditionally approved for shellfish harvesting, with the other nine stations located in areas classified as prohibited or restricted due to elevated fecal indicator bacteria levels or proximity to Safety Zones, including the NextEra Energy Seabrook Station nuclear facility, the Hampton WWTF, the Seabrook WWTF, the Hampton River Marina, and the NH Division of Ports and Harbors Hampton Harbor fueling/fishing offload facility (Nash & Dejadon, 2019) (Figure 12). NHDES closes conditionally approved areas following greater than one-inch rainfall events or following discharge of raw or partially treated sewage from the Hampton WWTF (Nash & Dejadon, 2019).

There are **two commercial shellfish aquaculture sites in Hampton Harbor**, both operated by Swell Oyster Company. One is a 1.1-acre bottom culture in the Hampton Falls River and the other is a 2.3-acre bottom culture area and 1-acre suspended culture area in the Browns River. Both sites are licensed for production of American oysters, softshell clams, and hardshell clams (Nash & Dejadon, 2019).

Hampton-Seabrook Estuary. © Peter Thornton

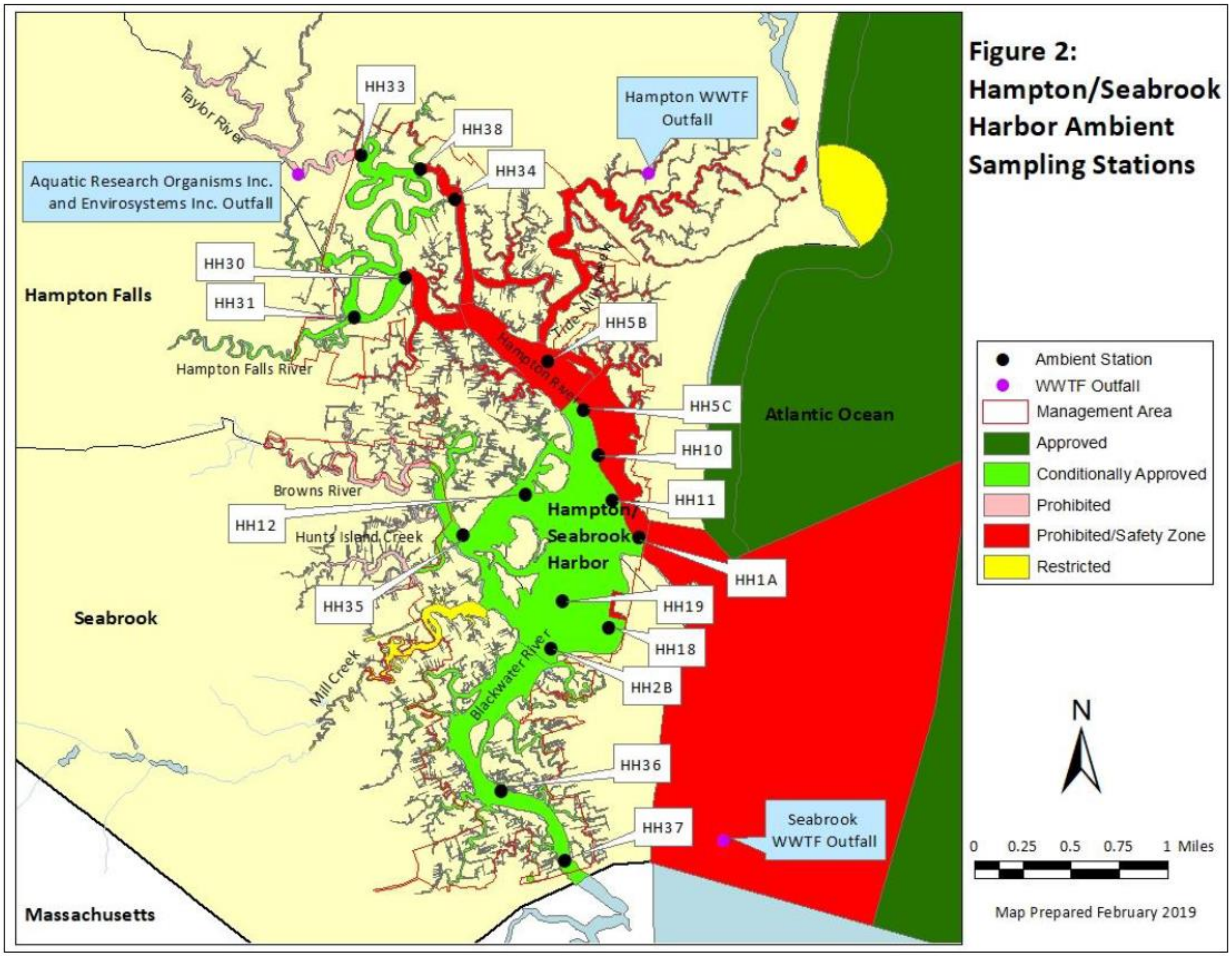


Figure 12. *Status of shellfish management areas in the Hampton-Seabrook Estuary (Nash & Dejadon, 2019).*

Other Recreational & Commercial Uses

As part of the New Hampshire seacoast, the towns of Hampton and Seabrook support a high proportion of seasonal **tourism** in the summer. Visitors come to these coastal towns to enjoy the summer recreation opportunities offered and to visit restaurants, concert venues, the Hampton Beach Casino, and other amusement attractions. The travel and tourism industry supports many jobs (e.g., hotels/motels, retail stores, restaurants, marinas, tour boats, etc.) and is **integral to the seacoast's economy** (Jones, 2000). The Town of Hampton Falls is more rural and does not provide municipal water and sewer to its residents like the towns of Hampton and Seabrook, and since the Town of Hampton Falls does not have a coastline, it experiences less tourism and seasonal influxes compared to the towns of Hampton and Seabrook.

The most popular tourist destination in the Hampton-Seabrook Estuary watershed (and along the New Hampshire seacoast) is the **village district of Hampton Beach** in Hampton, NH, which was established in 1907. Ocean Boulevard runs alongside the beach, along with a boardwalk, shops, seasonal hotels, and the Hampton Beach Casino, which provides top-name entertainment to the area. Hampton Beach hosts several popular and economically important events, including the Hampton Beach Seafood Festival (held the weekend after Labor Day each year) attended by more than 150,000 people, the Hampton Beach Sand Sculpture Competition (held in mid-June each year), and the Fourth of July Fireworks.

Recreational activities within the Hampton-Seabrook Estuary watershed include beach-going, surfing, swimming, boating, sailing, paddling, fishing, clamming, bird watching, sightseeing, walking, running, and bicycling (Town of Hampton, NH, 2021; Jones, 2000). There are several parks and recreation areas throughout the estuary's watershed. In Hampton, the Parks and Recreation Department manages 23 sites, which include Hampton Beach, Hurd Farm, White's Lane, the Hampton-Seabrook Marsh, Meadow Pond, Batchelder Farm and Park, Ice Pond, and the New Hampshire Seacoast Greenway (NHSG) (Town of Hampton, NH, 2021).

Fishing of both finfish and shellfish are common commercial and recreational activities within the estuary (refer also to the Shellfish & Harvesting section). Charter boats take guests offshore fishing for cod, flounder, mackerel, and other deep sea species (Jones, 2000). A group also harvests crabs in the Blackwater River to sell to restaurants. There are **eleven total marinas and mooring fields** within the estuary that cumulatively contain several hundred mooring slips (Figure 13). The marinas include Hampton River Marina and Boat Club, New Hampshire Division of Ports and Harbors Hampton Harbor Facility, and the Yankee Fisherman's Cooperative. The mooring facilities include the Hampton River Boat Club Mooring Field, Nudds Canal Mooring Field, Hampton River North Mooring Field, Hampton River East Mooring Field, Hampton River South Mooring Field, Seabrook Harbor Mooring Field, and Blackwater River Mooring Field. Recreational use of the marinas and mooring fields occurs from June through October, during which boat sewage discharge may be a potential source of pollutants to the estuary (Nash & Dejadon, 2019).

TOP: Boating. © Matt Parker.
MIDDLE: Moorings. © Ronald Grant.
BOTTOM: Paddlers. © Matt Parker.

To maintain safe navigation of the estuary, **periodic dredging of Hampton Harbor** is necessary. Three major dredges have been completed by the U.S. Army Corps of Engineers: 2004/2005 (110,699 cubic yards of sand removed), 2012/2013 (167,947 cubic yards of sand removed), and 2019 (estimated between 150,000-170,000 cubic yards of sand removed) (Nash & Dejadon, 2019). The dredged material is used to replenish the sand on Hampton and Seabrook beaches.

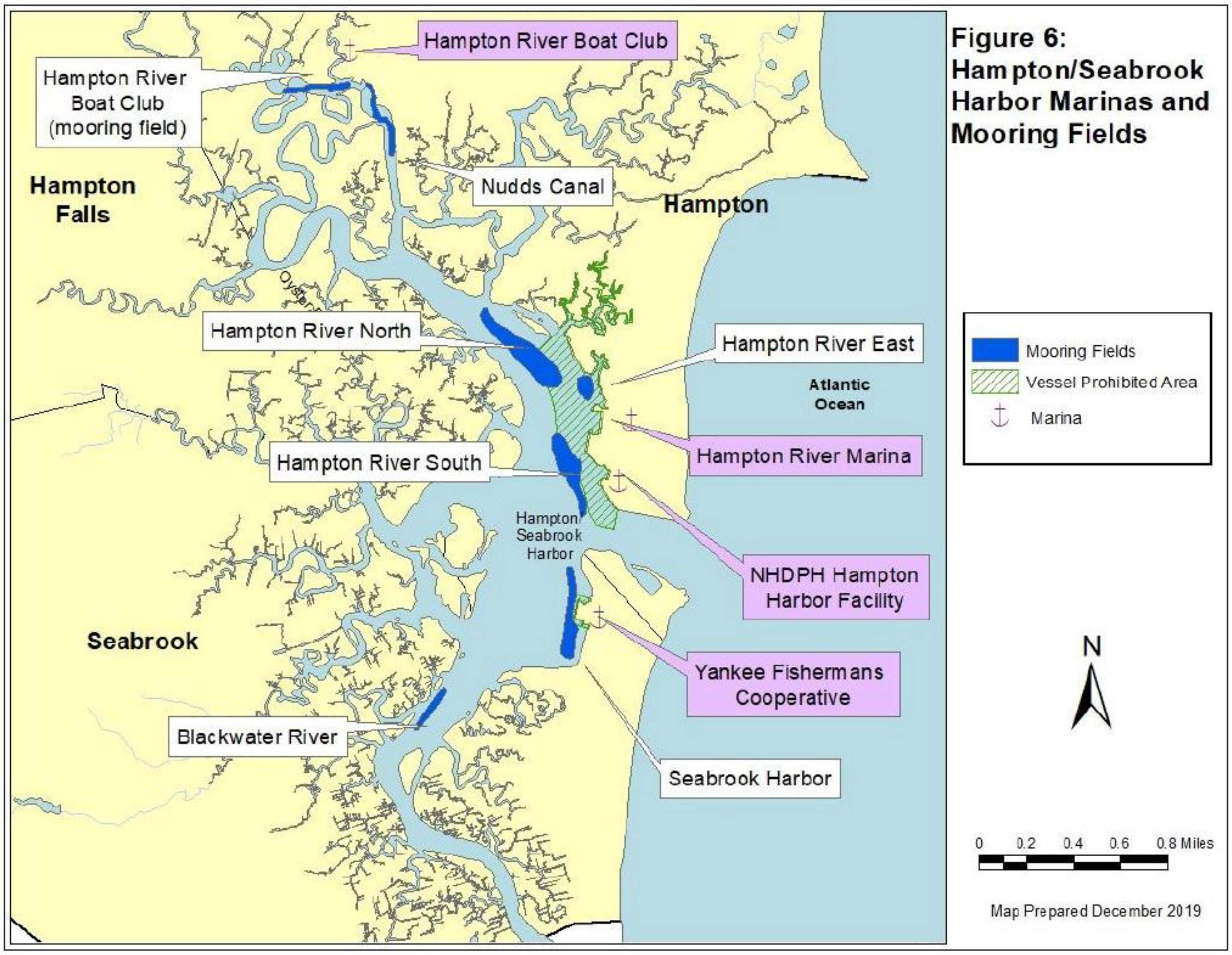


Figure 13. *Harbor marinas and mooring fields within Hampton Harbor (Nash & Dejadon, 2019).*

Existing Protection Policies & Regulations

Federal & State Regulations

Currently, all freshwater and estuarine streams, rivers, lakes, ponds, wetlands, and shoreland areas in New Hampshire are regulated and protected by federally mandated state regulations. State water quality standards for waterbodies (e.g., streams, rivers, lakes, ponds) are described in the Water Quality section. Applicable policies and regulations for wetlands, shorelines, and other natural resources are described below.

Freshwater and tidal wetlands (vegetated and open water complexes) are regulated by the state under NH RSA 482-A and Administrative Rules Env-Wt 100-900. Alterations to the land within wetlands, including excavation and fill, are reviewed and permitted by NHDES. The state has specific requirements and/or additional protections for coastal and tidal wetlands (Env-Wt 700), rivers and streams (Env-Wt 900), prime wetlands (Env-Wt 600), and resources within the tidal buffer zone (Env-Wt 700). The Hampton Salt Marsh Complex is protected by a local- and state-regulated tidal buffer zone (Env-Wt 103.66), which is an area extending landward 100 feet from the highest observable tide line (EF Design & Planning, 2020).

Under the New Hampshire Shoreland Water Quality Protection Act (Env-Wq 1400 & NH RSA 483-B), lakes, ponds, and impoundments greater than 10 acres in size and rivers fourth order and higher and their associated buffers are protected. Vegetation removal, excavation, and fill with 250 feet of these resources are regulated by NHDES, with specific requirements for actions within 50 feet (waterfront buffer), 150 feet (woodland buffer), and 250 feet (shoreland buffer). Municipalities have the authority to enforce local shoreland regulations in addition to the state's regulations. None of the three municipalities, Hampton, Hampton Falls, or Seabrook, have town-specific shoreland protection ordinances.

For upland areas outside of surface waters, wetlands, and their buffer areas, the state's Alteration of Terrain (AoT) rules and regulations (NH RSA 485-A:17 and Administrative Rules Env-Wq 1500) also protect water quality and the environment from stormwater pollution and sediment flushing from large development projects. When a project proposes to disturb more than 100,000 square feet of contiguous land, an AoT permit is required.

Natural resources exclusive to coastal areas are also regulated and/or managed by the state to protect public health or balance competing interests in land and water use at local, state, and federal levels. The NHDES Shellfish Program regulates the harvesting of shellfish in estuaries and along the coast. The NHDES' Coastal Program manages work within the Coastal Zone Management Act (CZMA) administered by NOAA.In 2019, New Hampshire adopted the 2015 International Building Code that requires all municipalities to comply with flood-related provisions. The primary requirement outlined in this code is that the elevation of new buildings must be at least one foot above base flood elevation (BFE). Although this one-foot requirement provides more protection, it will most likely have to be adjusted in the future to account for the expected two-to-five-foot rise in sea level by 2100.

Two of the three New Hampshire watershed towns (Hampton and Seabrook) are also required to comply with the six minimum control measures under the federally mandated New Hampshire Small MS4 General Permit. The Municipal Separate Storm Sewer System (MS4) permit covers illicit discharge detection and elimination plans (and ordinance inclusion), source control and pollution/spill prevention protocols, street sweeping, catch basins cleaning, and road/ditch maintenance, and education/outreach and/or training for residents, municipal staff, and stormwater operators, all of which are aimed at minimizing polluted runoff to surface waters.

Town Regulations

Hampton, Hampton Falls, and Seabrook each have specific policies and regulations regarding wetlands, land use, land conservation, and point and NPS pollution. Although there are several common themes across the three towns, there are considerable differences in terms of the scope and implementation of these regulations. In general, each town has their own community-based regulatory focus rather than a consistent regional plan that considers the estuary in its entirety. These regional plans have been developed by groups such as the RPC or TNC but have not been implemented by the towns, generating varying forms of policies and regulations for natural resources in the watershed. Below is a high-level summary of whether the towns have adopted various policies related to watershed protection (Table 4).

Table 4. *High-level summary of existing policies and regulations (EF Design & Planning, 2020). Refer to EF Design & Planning (2020) for more information defining each of these major policy and regulation categories.*

Existing Policies and Regulations	Town of Hampton	Town of Hampton Falls	Town of Seabrook
Wetland conservation district	Yes	Yes	No
Vernal pools protection	No	No	Yes
Designated "prime" wetlands	No	Yes	No
Low impact development required	Yes	No	Yes
Flood storage and storm surge buffering	Yes	No	Yes
Watershed protection ordinance	No	No	No
Zoning ordinance provisions for residential open space-conservation subdivisions	No	Yes	No
Minimum area of soil disturbance that triggers stormwater management regulations	No	No	Yes

In terms of wetland protections, the regulations in each of the three towns vary. Hampton and Hampton Falls both have clearly defined Wetland Conservation Districts (WCDs). All the towns have buffer and setback regulations, although these requirements are unclear for certain water resources, and the distances mentioned vary by town. Hampton and Hampton Falls specifically outline their regulations for tidal wetlands, non-tidal wetlands, prime wetlands, surface waters, and poorly drained soils. Hampton and Hampton Falls outline the prohibited uses within their defined WCDs, whereas Seabrook does not. These prohibited uses generally include the building of specific structures and the application of potential pollutants such as pesticides, herbicides, and fertilizers (EF Design & Planning, 2020).

All three towns have stormwater management and erosion and sedimentation controls in place for new development. These regulations are derived from the NH Stormwater Manual and therefore have common themes among them. Hampton and Seabrook require low impact development, while Hampton Falls does not. The primary difference among the three towns is the development requirements to control stormwater. In a review of stormwater regulations in each of the towns, it was recommended that they adopt the Southeast Watershed Alliance (SWA) model for their stormwater ordinances and set a common threshold for maximum allowable percent impervious cover by lot (EF Design & Planning, 2020).

For flooding, all three towns have floodplain ordinances in place but allow development and septic systems (for Hampton and Hampton Falls only) within the FEMA designated floodplain. Hampton and Seabrook have specific regulations regarding flood storage and storm surge buffering. The Town of Hampton requires new and substantially improved buildings near the tidal shoreline to follow more protective requirements than those in the 2015 International Building Code enforced by the state. Additionally, Hampton has implemented a parking program for residents who are impacted by flooding when tides are over 10 feet or during storm surges, allowing them to park their cars for free in municipal lots at higher elevations (Town of Hampton Code Section 805-9(M)(1)).

In terms of other water resources and environmental regulations, none of the three towns have Watershed Protection Ordinances. Each of the three towns have taken landscaping/vegetated buffer requirements into consideration; however, the reasoning behind these requirements varies. The Site Plan Review Regulations for Hampton and Hampton Falls reference landscaping for the purpose of screening/visually shielding properties and do not include specific considerations for wildlife and habitat enhancement. The Site Plan Review Regulations for Seabrook on the other hand specifically reference landscaping and vegetation to support wildlife and enhance habitat. Seabrook also implements incentives for using or keeping existing vegetation intact. Hampton Falls has zoning ordinances that contain provisions for residential open space-conservation subdivisions (EF Design & Planning, 2020).

Recommendations & Assessment

PREP prepared an environmental planning audit of municipal regulations referred to as *The Piscataqua Region Environmental Planning Assessment (PREPA)* (PREP, 2015; PREP, 2020). In this audit, PREP set standards for freshwater wetland protection, shoreland buffers and setbacks, stormwater management, and impervious surfaces to evaluate the protections that a town has in place. They recommended that Hampton, Hampton Falls, and Seabrook develop a coastal land conservation overlay district, implement mandatory conservation subdivision regulations (where possible for the Town of Seabrook, which is largely built-out with little opportunity for open space), and define a Fluvial Erosion Hazard (FEH) zone overlay. They highlighted that Seabrook and Hampton have explicit protections for vernal pools, whereas Hampton Falls does not. Hampton and Hampton Falls do not have a stated minimum area of soil disturbance that triggers stormwater management regulations, whereas Seabrook implements a 40,000 square foot minimum. PREP also identified that the three towns are not achieving the minimum design criteria for water quality volume/flow, groundwater recharge volume, and peak flow as defined in Volume 2 of the NH Stormwater Manual (EF Design & Planning, 2020).

Although Hampton, Hampton Falls, and Seabrook have already incorporated into their ordinances important regulations for natural resource protection, additional changes will be needed. Much work is still needed at the local, state, and federal regulatory levels to protect these natural resources and their valuable ecosystem services. Through CHAT, the Town of Hampton has been actively working to address key flooding issues through their regulations and planning. One challenge to the enactment of local regulations related to natural resource protection is enforcement, which can be limited by staffing capacity and other resources.

Future Threats

Ongoing climate change has important implications for the health of the Hampton-Seabrook Estuary that should be considered and incorporated into the EMP. Adding to the stress imposed by ongoing climate change is population growth and corresponding development in the watershed. The Hampton-Seabrook Estuary is at risk because of new development in the watershed unless climate change resiliency and low impact development strategies are incorporated into existing zoning standards.

Ongoing Climate Change

More frequent extreme precipitation events and rising sea levels are expected in the future due to climate change, the combined effect of which will cause more severe storm surges, flooding, habitat loss, and infrastructure damage in the Hampton-Seabrook Estuary watershed. This altered hydrology will impact sedimentation and land-forming processes in and around the estuary (PREP, 2018).

In the northeastern U.S., the frequency of **extreme precipitation events** (greater than one inch) is expected to increase over the next several decades, with a projected increase of 17% by mid-century and a 44% increase likely by the end of the century under the RCP 8.5 emissions scenario[4] for Rockingham County (refer to NOAA's Climate Explorer). An increase in the number of extreme precipitation events will cause more incidents of flooding in the region. Rivers and streams will also likely transport more nutrients and colored dissolved organic matter from the watershed to the estuary. Excess nutrients in surface waters can trigger algae blooms. Conversely, increases in colored dissolved organic matter in surface waters can significantly reduce the ability of light to penetrate through the water column, thereby limiting the growth of algae and submerged aquatic vegetation such as eelgrass.

Under the RCP 4.5 emissions scenario, estimates of **sea level rise** compared to 2000 levels for the New Hampshire seacoast region are 0.5 to 1.3 ft by 2050, 1.0 to 2.9 ft by 2100, and 1.2 to 4.6 ft by 2150 (NH Coastal Flood Risk Science and Technical Advisory Panel, 2020). Under the intermediate global mean sea level rise rate of 3.3 feet, it is predicted that **high tide flooding frequencies** will increase to 132±26 days per year by 2050 and will increase to a roughly daily occurrence by the end of the century (Wake, et al., 2019). For Hampton, under a 2-foot sea level rise scenario, 95% of high tides annually will exceed 10 feet, and the average number of days per year with a major flood (over 13 feet) will increase to 27 days (Chin & Howard, 2021). Much of the land within the Hampton-Seabrook Estuary watershed is at risk of becoming chronically inundated[5] during this century due to sea level rise (Wake, et al., 2019). The coastal high hazard area (VE Zone on FEMA Flood Insurance Rate Maps) has already expanded in Hampton, and predicted sea level rise indicates that coastal flooding will continue to worsen over time in Hampton and other coastal towns (Wake, et al., 2019). It is also anticipated that the velocity of tidal currents in the estuary will increase due to the greater volume of water passing through the estuary with sea level rise. The *New Hampshire Coastal Flood Risk Summary* estimates that "under high sea level rise scenarios, the

[4] RCP (Representative Concentration Pathway) 4.5 and 8.5 are part of the Coupled Model Intercomparison Project Version 5 (CMIP5). The RCP 4.5 emission scenario is a low to moderate prediction of the future. The RCP 8.5 emission scenario is considered a "business as usual" high prediction based on an unlikely future of increasing coal reliance. Even though the RCP 8.5 emission scenario may be an overprediction of future climate change impacts, most sources cite it as still a relevant and plausible future outcome to consider.

[5] Land is currently categorized as being chronically inundated when flooding occurs at least 26 times per year (Wake, et al., 2019).

flood and ebb tidal current could increase by more than 85% in the Hampton-Seabrook Estuary" (Wake, et al., 2019). In addition to impacting the flow of dissolved and particulate material in and out of the estuary, increased tidal currents may also impact erosion within the estuary, potentially exacerbating land loss caused by sea level rise.

A more recently studied impact of sea level rise that affects inland areas is **groundwater rise** (Wake, et al., 2019). Groundwater levels are influenced by a variety of factors including temperature, evapotranspiration, precipitation, runoff, snowmelt, land development, and sea level. As sea level along the coast rises, the denser saline groundwater extends farther inland and causes the less dense fresh groundwater to rise. As this groundwater rises, the boundaries of existing wetland areas will widen and low-lying dry areas where groundwater was shallow will transition into wetlands or develop into open water. In New Hampshire, the groundwater rise zone is projected to extend up to 2.5 to 3.0 miles inland from the coast (Wake, et al., 2019). This area is approximately three to four times farther inland than tidal water inundation and therefore expands the geographic scope of sea level rise impacts. Mean groundwater levels are projected to rise as a percentage of relative sea level rise, with the magnitude of groundwater rise decreasing with distance from the coast. Mean groundwater levels are projected to rise 66% of the projected relative sea level rise between 0.0-0.6 miles inland of the coast, 34% between 0.6-1.2 miles, 18% between 1.2-1.9 miles, 7% between 1.9-2.5 miles, and 3% between 2.5-3.1 miles of the coast. More than 5.0 feet of relative sea level rise-induced groundwater rise is projected to occur in approximately one-half of the land area within 0.6 miles of the coast with 6.6 feet of relative sea level rise (Wake, et al., 2019). Within the Hampton-Seabrook Estuary watershed, groundwater rise is anticipated to be contained to the immediate vicinity of the estuary, including the coastline and salt marsh areas.

With rising sea and groundwater levels and increased storm intensity and surge, flooding will occur farther inland, and existing salt marsh systems may disappear or migrate to higher elevations. **Salt marsh habitat and species loss** will be greatest in areas where salt marsh systems cannot retreat or migrate inland to escape rising sea levels, particularly due to developed areas adjacent to the salt marsh. In the 6.6-foot sea level rise scenario, 95% of the existing salt marsh in Hampton is projected to be lost by 2100 (EF Design & Planning, LLC, 2019) as high water levels drown the salt marsh, turning it into mudflat and eventually subtidal zone when the flood inundation persists. In open or natural areas, saltwater intrusion associated with sea level rise will cause freshwater areas to become brackish, thereby changing the flora and fauna present (NH Coastal Risk & Hazards Commission, 2016). SLAMM output comparing marsh habitat conditions in 2012 and 2060 show the potential impacts from sea level rise, namely the conversion of high marsh to low marsh and the conversion of tidal flats to open water, representing a loss in habitat for a number of ecologically and economically important species (Figure 14) (Kirshen, et al., 2018). These impacts could be lessened if the marsh accretion rate increases from its current rate of 1.71 mm/yr to 4 mm/yr or more, as preliminary data from other New Hampshire marshes have shown to be possible in response to sea level rise (Kirshen, et al., 2018). Other ecological impacts of flooding include sedimentation that can smother shellfish beds and coastal habitat alteration that can affect the timing of nesting and migration for seabirds (NHFG, 2015).

The **impacts to infrastructure and critical facilities** from flooding could range broadly depending on the magnitude of sea level and groundwater rise and storm surge. For example, under a 1.7-foot sea level rise scenario, 3.4 miles of roadways in Hampton would be impacted by flooding (RPC, 2015). This increases to 13.2 miles under a 4-foot sea level rise scenario and 20.6 miles under a 6.3-foot sea level rise scenario (RPC, 2015). These values become increasingly concerning when storm surge is considered. The

1.7-foot sea level rise scenario plus storm surge leads to 20.7 miles of roadways impacted, nearly the same amount as the 6.3-foot sea level rise scenario, considering astronomical tides alone (Chin & Howard, 2021; RPC, 2015). These infrastructure damages come at a high economic price. FEMA declared seven flood-related disasters in New Hampshire between 2013 and 2022, causing over $26 million in damage, which accounts for public assistance grant dollars only and not private flood insurance claims (FEMA, 2022). For the Town of Hampton, 3,065 parcels with a total assessed value of $1.2 billion were identified as being vulnerable to sea level rise and storm surge by the end of the century (EF Design & Planning, LLC, 2019).

Even though New England will face its challenges with flooding and extreme precipitation, **other forms of extreme weather** due to climate change will also impact the estuary and surrounding communities. Drought and dry conditions during the summer months will stress coastal New Hampshire's communities and natural environments. Extreme heat waves are projected to continue and intensify in the future, putting stress on water levels, exacerbating water quality issues, and degrading wildlife habitat conditions. This heat will also directly impact human populations, causing additional physical, emotional, and economic stress and health and safety concerns during the summer months. This added stress will carry over into the winter months as coastal New Hampshire is projected to experience more severe winter weather including heavy snowstorms, ice storms, Nor'easters, and high winds (Town of Hampton, NH, 2021).

Finally, marine waters are becoming more acidic due to the increased concentration of carbon dioxide in the atmosphere, a portion of which absorbs into the oceans. This **acidification** has a profound impact on ecosystem health, negatively impacting many important species including blue mussels, oysters, lobster, and flounder (PREP, 2018).

Hampton-Seabrook Estuary. © Matt Parker

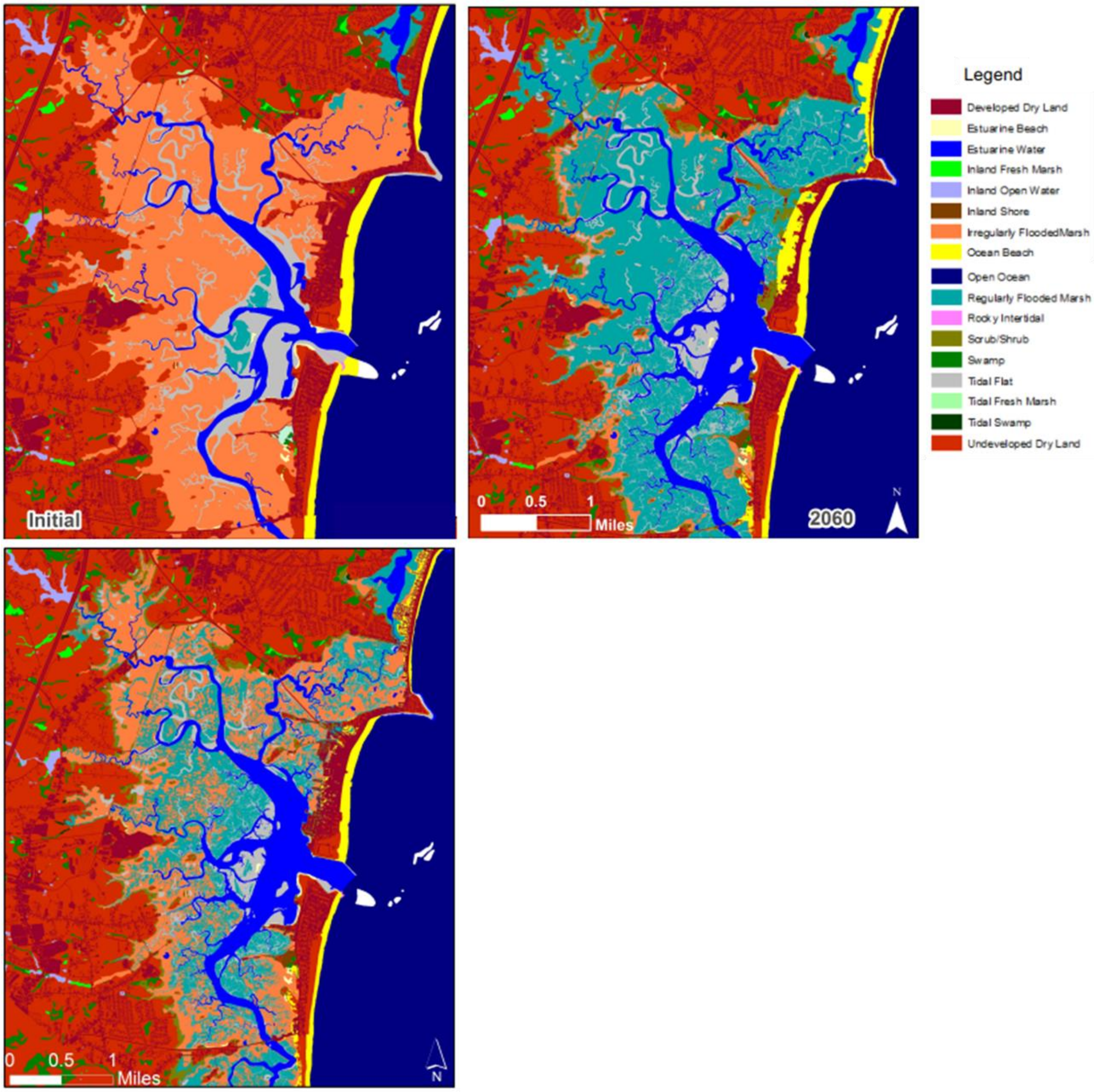


Figure 14. *SLAMM output showing the extent of 17 habitat types in 2012 (TOP LEFT) and 2060 with 0.73 m sea level rise, 1.71 mm/yr accretion rate (based on current rate), and development unprotected (TOP RIGHT) and with 0.73 m sea level rise, 6.00 mm/yr accretion rate (best case scenario), and development protected (BOTTOM LEFT). Note conversion of high marsh (orange) to low marsh (teal), new high marsh and transitional marsh (brownish green) at the upland edges, and conversion of tidal flat (gray) to open water (blue). Adapted from (Kirshen, et al., 2018).*

Future Development

The New Hampshire seacoast region, including the watershed towns of the Hampton-Seabrook Estuary, is at or near complete **buildout** (PREP, 2015). According to their respective master plans, the Town of Seabrook is 4% developable[6] (Town of Seabrook, NH, 2011), the Town of Hampton is 14% developable (Town of Hampton, NH, 2021), and the Town of Hampton Falls is roughly one-third developable (Town of Hampton Falls, NH, 2019). The sprawled development pattern in these coastal towns has generated fragmented habitats over time, leaving important natural resources and their ecosystem system services less resilient to stressors from human activities and ongoing climate change. With limited remaining developable land in these towns, most future development will be for redevelopment projects. Municipalities may also be forced to restore developed areas back to open land or conserve open or natural land to better accommodate salt marsh migration and safeguard the important flood protections provided by a large, well-functioning salt marsh system.

Buildout analyses identify areas with development potential and project future development based on a set of conditions and assumptions (e.g., zoning regulations, environmental constraints, population growth rate, etc.). These analyses show what land is available for development, how much development can occur, and at what density development can occur. It is important that municipalities utilize buildout analyses to help course-correct development regulations for better protection of natural resources that provide valuable ecosystem services.

Population growth and corresponding new development in the Hampton-Seabrook Estuary watershed will place further stress on the estuary. As population rises, so does the human footprint, which includes wastewater, fertilizers, toxic contaminants, and impervious surfaces. The watershed towns already have a high percentage of land that is covered by impervious surfaces. An increase in impervious surfaces within the watershed, in combination with enhanced precipitation, will increase the amount of contaminants that enter the estuary via stormwater runoff. Climate change models predict a 10-40% increase in stormwater runoff by 2050, particularly in winter and spring and an increase in both flood and drought periods as seasonal precipitation patterns shift. Greater freshwater input will flush more nutrients and other pollutants to surface waters which, along with warmer air temperatures, will allow algae to flourish. These events can also stir up underlying sediment, thereby further disrupting the biogeochemical balance of the estuary. Adopting local regulations that protect natural resources will be critical to the long-term health of the estuary and its ability to provide ecosystem services.

[6] In 2010, Seabrook determined its future residential development potential through a buildout analysis and their Housing and Conservation Planning Program. This work identified areas in Seabrook where future residential development cannot occur due to existing development and environmental constraints. From there, based on Seabrook's Zoning Ordinance, the minimum lot size was determined for each lot eligible for future development. Only 693 acres (11%) of the 6,160 acres of land in Seabrook were identified as not constrained. After the zoning evaluation of the parcels, only 249.6 acres (4%) were identified as being suitable for development in the future (Town of Seabrook, NH, 2011). The Town of Seabrook cautions the use of the 4% developable statistic as outdated since 2012 due to changes in land use ordinances.

Vision for the Estuary

Vision Statement

The Hampton-Seabrook Estuary is a thriving and resilient estuarine environment, home to healthy, diverse populations of fish, shellfish, birds, plants, and other native species and sustainably used by surrounding communities for its aesthetic, recreational, and economic benefits and ecosystem services. Local governments, residents, and visitors recognize, respect, and enjoy the watershed's connective habitats, litter-free beaches, and clean waters which form the bedrock of their community. Development occurs in a manner that protects both natural resources and infrastructure and allows the estuary and its watershed to naturally adapt to the effects of climate change, including, but not limited to, groundwater and sea level rise, coastal storm surges, and flooding.

Visioning Process

A **vision statement** provides a brief and compelling mental image of the estuary and its watershed as the community envisions it and serves as the aspirational pinnacle for the more detailed goals, objectives, and strategies that follow in this plan. The vision above reflects input from a broad spectrum of residents, visitors, municipal officials, business owners, water related professionals, and high school students in the watershed. This input was collected over two years though workshops, surveys, and interviews summarized below.

Figure 15. *Word cloud of one-word responses to why respondents love living in or visiting Hampton, Hampton-Falls, and Seabrook (Farrell Strategic Group, 2021).*

In June 2021, SHEA, with assistance from the Farrell Strategic Group, deployed a **30-question online survey** to residents and visitors of Hampton, Hampton Falls, and Seabrook. The results of that survey effort are presented in the *Public Visioning Survey Report* (Farrell Strategic Group, 2021). A summary of respondent demographics is provided in Table 5. Most (54%) of the 104 respondents were residents; of the residents, 44% were from Hampton. A smaller but significant number (31%) of the 104 respondents were visitors or former residents. Words used to describe why respondents enjoy living in or visiting the area are shown in Figure 15. They prominently featured themes of nature and beaches and their relaxing and peaceful attributes.

Over 90% of respondents saw the estuary as vital to flood protection, recreation, and shellfish habitat and agreed that a healthy balance between protection and recreational use of the estuary is important. Clamming and fishing have been long-standing recreational activities in the estuary for both novice and experienced harvesters. Hampton Harbor provides a working waterfront for commercial and recreational fishing interests. Many respondents hoped that conditions for clamming and fishing improve, leading to fewer resource closures and a return of this storied aspect of the estuary. Respondents also highly valued the watershed for its estuarine and upland habitat for wildlife, as well as its aquifers, which provide clean water for drinking. A large majority (89%) of respondents indicated that abundant diversity of fish, birds, shellfish, and plants were very or critically important to the health of the estuary.

Figure 16. *Word cloud of survey responses for "What's the biggest concern about the future of the estuary?" (Farrell Strategic Group, 2021).*

The most common activity cited by respondents was walking/jogging, along with several other nature-based activities, such as swimming, trail use, birdwatching, and seafood dining. The most common concerns reported by respondents included sea level rise, climate change, public access, and overdevelopment (Figure 16). Regarding what the coastline would look like in the future, respondents felt that there would be fewer buildings along the coastline, better building standards to withstand climate change impacts, more open space and conservation land, more people aware of their impact on the estuary, and better water quality for swimming, fish, and other species.

Figure 17. *Word cloud presenting Winnacunnet High School student values about the estuary. Source: SHEA.*

Relatively few respondents to the above survey (less than 5%) were under the age of 18, so SHEA conducted **additional listening sessions with Winnacunnet High School biology classes** in 2022. Responses from the high school students[7] aligned with the other community members. Words used to express the students' values about the estuary are presented in Figure 17. The students felt that

[7] A total of 53 students aged 18 and under were surveyed. Most students lived in Hampton (49%). Others lived in Seabrook (21%), Hampton Falls (21%), and North Hampton (9%). Most students had lived in the area their entire life (55%), while others had lived in the area most of their life (39%). A few students had recently moved to the area (6%).

fish and shellfish populations need to be protected through limitation of catch allotments and improvement of the species' habitat, as well as protection of land in and around the estuary, which could be achieved by implementing development restrictions and conservation. The students also wanted to see less intrusive and more conscientious motor boating and felt that education and signage could help reduce the impacts this type of recreation has on shoreline erosion. They also discussed the need to reduce pollution, both as solid waste and water quality contaminants including nutrients, which could be achieved largely through education of the community on good lawn care techniques and water pollution prevention more broadly. In general, the high school students felt more education about the estuary was needed for the community to best protect it.

Finally, an **additional round of surveys and interviews** were conducted in 2022 with six municipal officials or employees, including a planner, department of public works director, and conservation commission member from Hampton, a planner and water and sewer superintendent from Seabrook, and a conservation commission member from Hampton Falls. Two additional private sector professionals were also interviewed: a drinking water system director from Hampton and a local environmental engineer from Seabrook. From their collective experience, they described a community that greatly values the estuary as an essential feature and resource in Hampton, Hampton Falls, and Seabrook. It is part of the coastal community's identity both due to its high visibility and geographic centrality, as well as its cultural and historical significance.

Overall, the workshops, surveys, and interviews highlighted strong support by the community for environmental protection of the estuary and its watershed. To many whose family history is rooted in the area, the estuary represents their heritage. For generations if not thousands of years when considering use by the Abenaki people, the estuary has been well-loved and has served as an economic engine driving social community structure. To protect the estuary's functional integrity and biodiversity and the ecosystem services it provides, the watershed community, led by SHEA and the three municipalities, will need to collaboratively identify and manage threats and implement effective management strategies described herein.

***Table 5.** Summary of respondent demographics from the public visioning survey (Farrell Strategic Group, 2021). The left-hand table summarizes the count of responses by affiliation, town live in, and age range. The two right-hand tables summarize the count and percentage of responses by affiliation and town live in.*

Affiliation	Town Live In	Age Range	Count
Municipal	Hampton	45-54	1
Municipal	Hampton	65+	2
Resident	Hampton	Under 18	2
Resident	Hampton	18-24	3
Resident	Hampton	25-34	1
Resident	Hampton	35-44	5
Resident	Hampton	45-54	6
Resident	Hampton	55-64	9
Resident	Hampton	65+	15
Resident	Hampton Falls	35-44	1
Resident	Hampton Falls	45-54	1
Resident	Hampton Falls	55-64	2
Resident	Hampton Falls	65+	1
Resident	Seabrook	45-54	1
Resident	Seabrook	55-64	2
Resident	Seabrook	65+	7
Visitor	Other	25-34	4
Visitor	Other	35-44	8
Visitor	Other	45-54	4
Visitor	Other	55-64	5
Visitor	Other	65+	9
Visitor	Other	No Response	1
Worker	Other	55-64	1
Former Resident	Hampton	65+	1
Business Owner	Hampton	Under 18	1
No Response	No Response	No Response	11
		Total	**104**

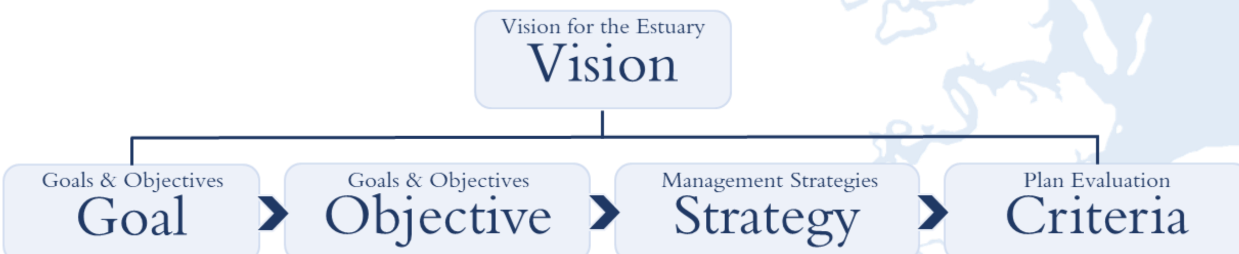
Affiliation	Count	Percentage
Municipal	3	3%
Resident	56	54%
Visitor	31	30%
Worker	1	1%
Former Resident	1	1%
Business Owner	1	1%
No Response	11	11%
Total	**104**	**100%**

Town Live In	Count	Percentage
Hampton	46	44%
Hampton Falls	5	5%
Seabrook	10	10%
Other	32	31%
No Response	11	11%
Total	**104**	**100%**

Goals & Objectives

The following goals and objectives are based on the vision statement and review of documents relevant to the Hampton-Seabrook Estuary, notably the *HSE Salt Marsh Management Goals Explored at the Hampton-Seabrook Estuary Working Webinar 1 Getting on the Same Page* (Jalbert Leonard, Dionne, Lucey, Mattera, & Meaney, 2021), as well as review of other estuary management plan approaches.

Five goals are presented below, each followed by several objectives. Each of the five goals is a topical theme derived from the vision statement for the estuary. Objectives identified for each goal provide specific targets to fulfill each goal. Some objectives are relevant to multiple goals but are only shown once under the most applicable goal. For example, Goal 2 objectives offer natural strategies to combat flooding, while Goal 5 objectives offer strategies related to municipal land use planning and equity principles that also address flooding or the environmental justice impacts from flooding. Subsequent sections of the plan identify strategies or specific actions to achieve each objective, along with criteria to evaluate the successful execution of each strategy or action item.



Conceptual diagram of the planning components and their chapter locations (smaller header text).

Goal 1. A thriving, healthy estuarine environment with an abundant diversity of fish, birds, plants, and other native species is achieved and maintained.

Objectives:

1.1. Maintain clean, clear waters which sustain designated uses through the institution of stormwater, wastewater, and other pollutant management measures, including buffer enhancement that reduce contaminated runoff and groundwater to surface waters.

1.2. Implement habitat and ecosystem services restoration activities where and as needed, including upland buffer protection, ditch remediation, fish passage restoration, and oyster bed and clam flat restoration.

1.3. Track and manage invasive species to limit competition with or degradation of native populations.

1.4. Identify, monitor, and protect endangered and threatened native species and species at risk or of greatest conservation need.

Goal 2. Flood storage and mitigation benefits are protected and enhanced for ecosystem resiliency and sustainable infrastructure protection.

Objectives:

2.1. Monitor and minimize bank and shoreline erosion through improved stabilization and resiliency of living shorelines.
2.2. Accommodate and encourage marsh migration.
2.3. Monitor subsidence/accretion of the salt marsh, with accretion enhanced to build up salt marsh elevation.
2.4. Protect dunes from development pressures to better safeguard existing infrastructure from more frequent and larger storm surges.
2.5. Restore hydrologic function to floodplains areas, buffer zones, groundwater, tidal flow, etc.

Goal 3. Recreational and commercial opportunities are well-managed and sustainable, with equitable, safe, and enjoyable access to the public.

Objectives:

3.1. Maintain healthy and sustainable resource populations to support fishing and clamming activities.
3.2. Create and maintain a healthy, litter-free natural environment with clean water for recreation such as bird watching, hiking, swimming, kayaking, etc.
3.3. Manage access points to maximize safe and fair access and minimize environmental damage from human, animal, and vehicle traffic, overcrowding, or other negative effects.

Goal 4. Education, outreach, and volunteer activities link the community with the estuary. The community is well-informed and active in protecting the estuary and its watershed.

Objectives:

4.1. Keep the community well-informed so it can actively support protecting the estuary, watershed, and drinking water sources.
4.2. Engage citizen scientists and other community members to partner with research and monitoring.
4.3. Utilize multiple channels for outreach and education to reach the most community members and stakeholder groups.
4.4. Encourage and support voluntary actions to protect the watershed (e.g., land trusts, conservation easements, sustainable landscaping).

Goal 5. Planning and management efforts utilize sound science and are coordinated and implemented to protect vital ecosystem services, adapt to the effects of climate change, and ultimately ensure the health, safety, and well-being of the people who live in and visit the watershed.

Objectives:

5.1. Implement zoning and building code updates and/or planning documents to prevent overdevelopment and ensure infrastructure resilience to heightened storms and flooding.
5.2. Coordinate land conservation of critical habitats, particularly in support of marsh migration and/or habitat connectivity across jurisdictions at the watershed level.
5.3. Protect drinking water sources with zoning, regulation, maintenance, and sustainable funding.

5.4. Maintain navigation of Hampton Harbor, including managing the extraction and placement of dredge materials in an environmentally sound manner based on the best available data.
5.5. Coordinate levels of government (local, state, and federal), academic institutions, and other stakeholder groups to protect and monitor the environment.
5.6. Conduct research and monitoring to address data gaps, with results made readily accessible to resource managers for decision making.
5.7. Consider environmental justice principles for communities, especially marginalized populations that will be most impacted by climate change.

Hampton-Seabrook Estuary. © Matt Parker

Management Strategies

The following section details management strategies for achieving the goals and objectives, as well as education and outreach and adaptive management approaches. Strategies outlined below include stormwater management and pollutant reduction measures, flood response, shoreline stabilization, land conservation, local planning and regulations, harbor operations and navigation, shellfish management, wildlife habitat protection, environmental justice, and public access. A key component of these strategies is the idea that existing and future development can be remediated or conducted in a manner that sustains environmental values. All stakeholder groups have the capacity to be responsible watershed stewards, including citizens, businesses, the government, and others. Specific action items are provided in the Action Plan (Appendix B).

High & Near-Term Priority Action Items

Given the broad spectrum of identified management strategies for the estuary, prioritization of the action items is difficult, depending on the background, experience, and interests of those performing the prioritization. In addition, many of the goals and objectives are interrelated or dependent on one or another, making the process of teasing out individual action items effectively impractical as stand-alone priorities within the larger arch of restoration. The process of restoration typically follows a progressive pattern of research, planning, implementation, and monitoring. Therefore, action items related to implementation generally cannot proceed without prior research and planning to identify and design restoration needs. Finally, the schedule for executing the action plan should be considered fluid and dependent on alignment of resource availability at any given time.

With this understanding, we present here high priority actions (identified by the Advisory Committee) for each of the major goals. High priority actions to address in the near-term include the following:

- **Stormwater and other pollutant reduction management measures:** require low impact development techniques; enhance buffers; optimize MS4 compliance; enforce septic system regulations.
- **Salt marsh resiliency and flood response:** stabilize banks through living shorelines; conserve and/or restore natural buffer and migration areas; remediate ditching; replace restrictive tidal crossings.
- **Local planning and regulations:** adopt the Hampton-Seabrook EMP into each town's Master Plan; implement coastal resilience report recommendations; limit development in CFAs; develop liaison programs for community-based organizations to participate in hazard mitigation and climate resilience planning; enhance emergency access and evacuation routes; provide affordable, resilient housing; require hazard zone disclosure information be provided to new homebuyers and renters.
- **Shellfish management:** continue to fund the NH Shellfish Program; continue to document rain-driven water quality impacts on shellfish growing areas.
- **Improve wildlife habitat:** remove barriers to fish passage.

- **Harbor navigation:** use beach profiling data to inform where dredge materials may be most beneficial.
- **Research and networking:** coordinate a water level gauging network for the Hampton-Seabrook Estuary; evaluate six existing Surface Elevation Tables (SETs) on a bi-annual cycle; coordinate with other stakeholders to build a sense of shared ownership; initiate long-term vegetation monitoring in the salt marsh; develop a sediment budget for the estuary; investigate the effects of tidal crossings and their replacements on salt marsh health; conduct an assessment of the economic impacts from sea level rise; complete assessment of nutrients, sediment, seagrasses, fish, and oysters to determine co-variability in health.
- **Outreach and community engagement**: enhance public access and recreational engagement safely and equitably; install informational kiosks at viewpoints; convene clean-up days; offer field trips; distribute information on coastal resiliency through a variety of formats; engage with community-based organizations and youth groups.

Stormwater Management & Pollutant Reduction Measures

Development generates stormwater runoff from impervious surfaces, introducing pollutants to surface waters. Recommendations to protect surface waters start by identifying problem areas. Problem areas are locations that contribute disproportionate amounts of pollutants to surface waters. These pollutants can include sediment, phosphorus, nitrogen, oils and greases, household chemicals and soaps, heavy metals, and bacteria. Problem areas can be identified through watershed surveys, long-term water quality monitoring, investigatory sampling, septic system surveys, and sanitary sewer line inspections. Once problem areas within a watershed are identified, appropriate management measures can be determined and implemented.

Stormwater management includes both **structural and non-structural NPS restoration techniques**. **Structural NPS restoration techniques** are engineered infrastructure designed to intercept stormwater runoff, often allowing it to soak into the ground, be taken up by plants, harvested for reuse, or released slowly over time to minimize flooding and downstream erosion. These **Best Management Practices (BMPs)** often incorporate some mechanism for pollutant removal, such as sediment settling basins, oil separators, filtration, or microbial breakdown. They can also consist of removing or disconnecting impervious surfaces, which in turn reduces the volume of polluted runoff generated, minimizing adverse impacts to receiving waters. For the proper installation of structural BMPs in the watershed, SHEA and other stakeholders should work with experienced professionals on sites that require a high level of technical knowledge (engineering). Whenever possible, pollutant load reductions should be estimated for each BMP installed. **Non-structural NPS restoration techniques** refer to a broad range of behavioral practices, activities, and operational measures that contribute to pollutant prevention and reduction, including buffer protection, pollutant reduction best practices, septic system design and maintenance, sanitary sewer system inspections, fertilizer use prohibition, agricultural practices, pet waste management, and nuisance wildlife controls, as described below.

Buffer Protection

Protecting, improving, and establishing vegetative buffers around the estuary and other critical water resources in the Hampton-Seabrook Estuary watershed is a top priority management recommendation for the three watershed towns (PREP, 2015). Buffers can help to intercept and filter polluted stormwater runoff from impervious surfaces before reaching surface waters. Maintaining or establishing natural buffer conditions will also make the salt marsh more resilient to sea level rise by allowing for marsh migration. See the Salt Marsh Migration & Resilience and Land Conservation sections for identification and discussion of key buffer areas to restore and protect around the estuary.

Pollutant Reduction Best Practices

Pollutant reduction best practices include recommendations and strategies for improving road management and municipal operations for the protection of water quality. Following standard best practices for road maintenance and drainage management protects both infrastructure and water quality through the reduction of sediment and other pollutant transport. The Town of Hampton has been improving and replacing failing road, drainage, and water infrastructure along the estuary, as well as Meadow Pond, to protect its water resources, but the Town of Hampton could more efficiently identify and address aging drainage infrastructure and update maintenance practices through a comprehensive stormwater infrastructure plan (Town of Hampton, NH, 2021; Town of Hampton, NH, 2023).

Two of the three New Hampshire watershed towns (Hampton and Seabrook) are required to comply with the six minimum control measures under the New Hampshire Small MS4 General Permit. The Town of Hampton Falls should also consider instituting the permit's key measures, such as street sweeping, catch basin cleaning, and road/ditch maintenance. As a next step, it is recommended that SHEA reach out to each town's DPW to better understand what each town is currently doing to comply with the MS4 permit and how those activities align with the EMP's goals and management strategies.

Septic System Design & Maintenance

When properly designed, installed, operated, and maintained, septic systems can treat residential wastewater and reduce the impact of excess pollutants in ground and surface waters. It is important to note, however, that traditional septic systems are designed for pathogen removal from wastewater and not specifically for other pollutants such as nutrients. The phosphorus in wastewater is "removed" only by binding with soil particles or recycled in plant growth but is not removed entirely from the watershed system. Nutrient removal can only be achieved through more expensive, alternative septic systems. Proper design, installation, operation, maintenance, and replacement considerations include the following:

- Proper **design** includes adequate evaluation of soil conditions, seasonal high groundwater or impermeable materials, proximity of sensitive resources (e.g., drinking water wells, surface waters, wetlands, etc.);
- Proper siting and **installation** mean that the system is installed in conformance with the approved design and siting requirements (e.g., setbacks from waterways);
- Proper **operation** includes how the property owner uses the system. While most systems excel at treating normal domestic sewage, disposing of some materials, such as toxic chemicals, paints, personal hygiene products, oils and grease in large volumes, and garbage, can adversely affect the function and design life of the system, resulting in treatment failure and potential health threats; proper operation also includes how the property owner protects the system; allowing vegetation with extensive roots to grow above the system will clog the system; driving large vehicles over the system may crush or compact piping or leaching structures;

- Proper **maintenance** means having the septic tank pumped at regular intervals to eliminate accumulations of solids and grease in the tank; it may also mean regular cleaning of effluent filters, if installed. The frequency of septic pumping is dependent on the use and total volume entering the system. A typical 3-bedroom, 1,000 gallon tank should be pumped every 3-4 years;
- Proper **replacement** of failed systems, which may include programs or regulations to encourage upgrades of conventional systems (or grandfathered cesspools and holding tanks) to more innovative alternative technologies.

Management strategies for reducing water quality impacts from septic systems (as well as cesspools and holding tanks) start with education and outreach to property owners so that they are better informed to properly operate and maintain their systems. Other management strategies include setting local regulations for enforcing proper maintenance and inspection of septic systems and establishing funding mechanisms to support replacement of failing systems (with priority for cesspools and holding tanks).

Sanitary Sewer System Inspections

Because a significant portion of the watershed also relies on a municipal sewer system, it is important for municipalities with sewer to develop a program (if not already in place) to inspect and evaluate their sanitary sewer system and reduce identified leaks and overflows, especially in areas near waterbodies. Failures occur due to a combination of infrastructure age and lack of maintenance. Infrastructure near the coast is especially vulnerable to failure due to pressure and corrosion from tidal inundation. Sewer lines and other infrastructure placed directly in the estuary also present challenges for maintenance and replacement when seasons and tide cycles must be considered. The towns of Hampton and Seabrook have many old clay sewer lines near the estuary that need replacement. The Town of Hampton identified 22 sewer manhole rehabilitation sites, as well as other vulnerable sewer infrastructure in the areas of Ross Avenue, Charles Street, and Kentville Terrace near the estuary, that are being prioritized for replacement and upgrade. The Town of Seabrook completed a climate resiliency assessment for its WWTF to better plan for continued flooding and sea level rise (Weston & Sampson, 2021). The assessment recommends a "passive approach" of building up the site's ability to fend off flooding, allowing the site to be cut off from dry land access, and setting up infrastructure to operate the site remotely (Weston & Sampson, 2021). However, the assessment recommends that the Town of Seabrook invest in a new WWTF at an upland location by 2050 (Weston & Sampson, 2021).

Fertilizer Use Prohibition

Management strategies for reducing water quality impacts from residential, commercial, and municipal fertilizer application start with education and outreach to property owners. New Hampshire law prohibits the use of fertilizers within 25 feet of surface waters. Outside of 25 feet, property owners can get their soil tested before considering application of fertilizers to their lawns and gardens to determine whether nutrients are needed and if so in what quantity or ratio. A soil test kit can be obtained through the UNH Cooperative Extension. Many New England communities are starting to adopt local regulations prohibiting the use of both fertilizers and pesticides, most especially near critical waterbodies.

Agricultural Practices

Manure and fertilizer management and planning are the primary tools for controlling nutrient runoff from agricultural areas. Direct outreach and education should be conducted for both small hobby farms and larger-scale operations in the watershed. The NRCS is a great resource for such outreach and education to farmers. Larger-scale agricultural operations can work with the NRCS to complete a Comprehensive Nutrient Management Plan (CNMP). These plans address soil erosion and water quality concerns of agricultural operations through setting proper nutrient budgets, identifying the types and amount of nutrients necessary for crop production (by conducting soil tests and determining proper calibration of nutrient application equipment), and ensuring the proper storage and handling of manure. Manure should be stored or applied to fields properly to limit runoff of solids containing high concentrations of nutrients. Manure and fertilizer management involve managing the source, rate, form, timing, and placement of nutrients. Writing a plan is an ongoing process because it is a working document that changes over time.

Pet Waste Management

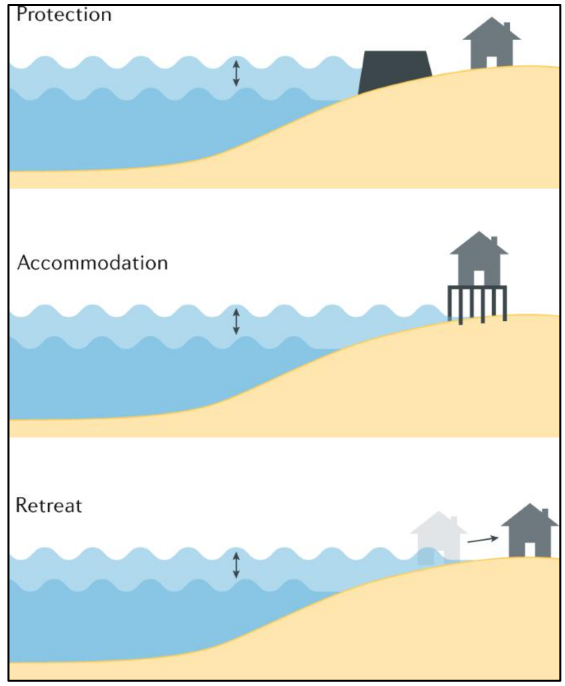
Pet waste collection as a pollutant source control involves a combination of educational outreach and enforcement to encourage residents to clean up after their pets. Public education programs for pet waste management are often incorporated into a larger message of reducing pollutants to improve water quality. Signs, posters, brochures, and newsletters describing the proper techniques to dispose of pet waste can be used to educate the public and create a cause-and-effect link between pet waste and water quality. Adopting simple habits, such as carrying a plastic bag on walks and properly disposing of pet waste in dumpsters or other refuse containers, can make a difference. It is recommended that pet owners do not put dog and cat feces in a compost pile because it may contain parasites, bacteria, pathogens, and viruses that are harmful to humans and may or may not be destroyed by composting. "Pooper-scooper" ordinances are often used to regulate pet waste disposal. These ordinances generally require the removal of pet waste from public areas, other people's properties, and occasionally from personal property, before leaving the area. Fines are typically the enforcement method used to encourage compliance with these ordinances.

Nuisance Wildlife Controls

Human development has altered the natural habitat of many wildlife species, restricting wildlife access to surface waters in some areas and promoting access in others. Minimizing the impact of wildlife on water quality generally requires either reducing the concentration of wildlife (e.g., geese, ducks, seagulls, etc.) in an area or reducing their proximity to a waterbody. In areas where wildlife is observed to be a large source of nutrient contamination, such as large and regular congregations of waterfowl, a program of repelling wildlife from surface waters (also called harassment programs) may be implemented. These programs often involve the use of scarecrows, kites, a daily human presence, or modification of habitat to reduce attractiveness of an at-risk area. Providing closed trash cans near waterbodies, as well as discouraging wildlife from congregating and entering surface waters by limiting large open mowed areas, installing fences, pruning trees, or making other changes to landscaping, can reduce impacts to water quality. Public education and outreach on prohibiting waterfowl or other wildlife feeding is an important step to reducing the impact of nuisance wildlife.

Flood Response

Strategies for managing increased flooding can be binned into the following responses: accommodation, protection, and retreat. **Accommodation** responses live with the water (e.g., raising house elevations). **Protection** responses control water through hard or natural solutions (e.g., sea walls or living shorelines). **Retreat** responses move out of the water (e.g., voluntary property buyout programs). These response strategies are largely discussed in other sections: Buffer Protection, Shoreline Stabilization, Land Conservation, Local Planning & Regulations, and Environmental Justice. This section focuses on flood mitigation and adaptation strategies that upgrade infrastructure and restore natural hydrologic function through salt marsh migration and resilience and dune restoration.



Strategies for future flood response (Hauer, et al., 2020).

Infrastructure Upgrades

To plan and prepare for increased flooding, the watershed towns will need to continue documenting and identifying current and projected flood areas and their vulnerabilities. Areas within floodplains that contain roads, homes, and other infrastructure are especially vulnerable to flooding impacts. Noteworthy infrastructure in the watershed that is critical to protect includes the NextEra Energy Seabrook Station nuclear facility, the Seabrook WWTF, and the Hampton WWTF. Other critical infrastructure in need of resiliency upgrades in the three watershed towns were identified in a coastal vulnerability assessment (RPC, 2015). Additional critical infrastructure will likely be identified using the **NH Coastal Flood Risk Model**, anticipated for public release by January 2024.

The towns of Hampton, Hampton Falls, and Seabrook have been gradually upgrading and replacing public stormwater and wastewater infrastructure in need of repair, with priority projects addressed each year. Culverts and stormwater drains tend to be systematically replaced in conjunction with roadway repairs and replacement, unless there are failures that require immediate attention. Currently, Seabrook places sandbags around the sewer vault near the intersection of Route 286 and 1A during high water events. This and

NH Coastal Flood Risk Model

NHDES contracted with the Woods Hole Group to develop a hydrodynamic flood risk model for the New Hampshire seacoast. Current projected inundation maps for the New Hampshire seacoast are based on overlaying different sea level rise scenarios on topographic maps, a simplistic process that does not account for variable water levels in such areas as the Hampton-Seabrook Estuary. The updated model will provide more accurate representation of water levels and flood conditions under various sea level rise, tidal, and storm surge scenarios. Anticipated for a January 2024 release, the model will be made publicly available for anyone to use for site-specific simulation of flood conditions, allowing for informed decision-making related to protecting and managing both natural resources and infrastructure.

other types of emergency or short-term responses will need to be replaced with sustainable solutions that adapt to flooding, such as elevating structures and roads and improving drainage in flood areas.

NHDES completed environmental assessments for all tidal crossings in the state. Information on New Hampshire's tidal crossings can be found online through the NH Coastal Viewer mapping tool and in the *Resilient Tidal Crossings: An Assessment and Prioritization to Address New Hampshire's Tidal Crossing Infrastructure for Coastal Resilience* report (NHDES, 2019). There are ongoing efforts to assess and collect environmental data for all freshwater crossings. Information on New Hampshire's freshwater stream crossings can be found online through the NHDES' Aquatic Restoration Mapper and NHDES' Stream Crossing Initiative website. These datasets include condition and environmental factors that can be used to identify and prioritize where work should be done. Designs for replacement and upgrades to crossing infrastructure should allow for marsh migration, rising tidal waters due to sea level rise, and higher water volumes associated with more severe storms. Around the Hampton-Seabrook Estuary, there are 36 assessed tidal crossings, with 86% identified as high priority for replacement due to tidal restriction (NHDES, 2019). The Town of Hampton Falls identified a small bridge on the U.S. Route 1 crossing over the Taylor River as a high priority NHDOT project to restore tidal flow.

Salt Marsh Migration & Resilience

Nationally, salt marshes and other wetlands provide billions of dollars in ecosystem services related to flood protection; yet we are losing salt marshes to sea level rise because natural migration is hindered by steep slopes, development, or infrastructure (NERRS & NOAA, 2021). As part of a nationwide study, the Great Bay NERR completed an assessment of New Hampshire's salt marshes that evaluated metrics of marsh resilience: current marsh conditions, vulnerability to sea level rise, and adaptive capacity. Based on the results of the assessment, the resilience of each marsh unit was determined and matched with a management option. Management options include protection, adaptation, and restoration approaches that range widely in costs, allowing decision-makers to easily identify marsh areas to invest protection efforts in based on ecological and financial feasibility. Five marsh units (Landing Rd in Hampton; JH Sanborne in Hampton Falls, and Beckmans Island, Mill Creek, and Walton Rd in Seabrook) in the Hampton-Seabrook Estuary were identified as highest priority for land conservation and minor restoration (i.e., ditch remediation) due to their good current condition, low vulnerability to sea level rise, and high adaptation potential for marsh migration in response to sea level rise (GBNERR, 2022). See Land Conservation for discussion of prioritized land acquisition opportunities for salt marsh migration.

Remediate Ditches in the Hampton-Seabrook Estuary

With funding from a NFWF National Coastal Resilience Grant, the Town of Hampton identified four areas in the Hampton-Seabrook Estuary salt marsh for a demonstration project showcasing ditch remediation as a nature-based solution to flooding. Ditch remediation helps to prevent salt marsh loss which in turn helps to increase salt marsh resiliency and its ability to absorb flooding. Others, such as the Parker River Wildlife Refuge and the Massachusetts Trustees for Reservations, have been successful at mowing salt marsh grasses adjacent to ditches and attaching the grasses to the bottom of the ditches with twine. The grasses slow water flow and promote sediment and vegetation in-filling of the ditches over time. The Town of Hampton, with assistance from SLR and NHDES, plan to implement the ditch remediation demonstration project in 2023.

Much work is already underway to restore the Hampton-Seabrook Estuary salt marsh. The UNH Coastal Habitat Restoration Team and NHDES actively work to **remediate ditches**, control invasive species (see

Wildlife Habitat Protection), and raise marsh surface elevation using thin layer placement (Moore, n.d.). UNH has been developing and implementing innovative restoration and monitoring techniques for improved marsh platform resilience and dune management in New Hampshire.

Dune Restoration

Dunes are especially important to maintain or restore to maximize their ability to protect infrastructure and inland habitats from storm surge and flooding. Although there are state, federal, and private funding sources and state statutes and regulations designed to protect dunes, this information is generally not well known to the public. Education about sand dunes targeted at landowners adjacent to them may help better sustain them, particularly given that much of New Hampshire's dunes are located on private land (Eberhardt & Burdick, 2008). Recommendations to landowners should focus on limiting foot traffic and new pathway construction through the dunes. New Hampshire coastal communities might consider requiring elevated walkways for dune access design standards like the Town of Salisbury, MA.

Because remnant sand dunes are unable to naturally replenish their sand reserves and shift in response to erosive forces such as wind, waves, and storms, restoration efforts must simulate sedimentation and erosion processes to maintain the health and function of the dune system. Dune restoration can be difficult and costly as dunes are very sensitive to environmental conditions, and the required machinery can be large and complex (Eberhardt & Burdick, 2008). Because of this, dune restoration should focus on areas impacted by minor disturbances, such as de-vegetation, walkway construction, and other recreational activities. **Dune restoration techniques include:** (1) importing sand to rebuild dune height and extent (recommend pairing with dredging projects to reduce costs); and (2) installing semi-permeable barriers such as sand fencing or vegetation to naturally accrete sand (fencing requires long-term maintenance). American beachgrass is commonly used in foredune restoration efforts. Planting additional species in the foredune and interdune zones is recommended to increase species diversity and resilience. Volunteers can be utilized for the planting and monitoring of dune vegetation until it becomes established.

The **UNH Coastal Habitat Restoration Team** has worked with over one thousand volunteers, including school groups and local conservation commissions, to help restore dunes along the New Hampshire and Massachusetts seacoasts. To build dune resiliency, they plant native plants, including American beachgrass, seaside goldenrod, beach pea, and sea rocket, bayberry, and beach plum. They also install sand fencing and post educational signage. Dunes are surveyed for sand accretion to document project success. **There are currently 25 permanent dune survey transects monitored quarterly by UNH.** UNH also conducts research on the sand trapping effectiveness of different plant species and the impact of a pathogenic nematode worm on dune die-off.

Dune restoration work in progress. © UNH Coastal Habitat Restoration Team.

Shoreline Stabilization

The need for adaptive and resilient coastal shoreline stabilization techniques is growing in New Hampshire, as rising sea levels and more frequent and intense storm events erode non-hardened shoreline areas along the seacoast, including within the Hampton-Seabrook Estuary. The first step in shoreline stabilization includes monitoring bank erosion and identifying areas where erosion control methods could be implemented. In 2019, a group of state and federal environmental agencies developed a model to identify living shoreline stabilization methods and suitability for New Hampshire's coastal shorelines (Balasubramanyam & Howard, 2019). A **living shoreline** is a management practice that provides erosion control benefits, protects, restores, or enhances natural shoreline habitat, and maintains coastal processes through the strategic placement of plants, stone, sand, and other structural organic materials. Living shorelines reduce bank erosion and sedimentation through wave energy attenuation and maintain the continuity of the natural land-water interface, while also providing habitat value, absorbing pollutants, and improving carbon sequestration (Balasubramanyam & Howard, 2019).

Balasubramanyam & Howard (2019) found that most of New Hampshire's coastal shorelines are suitable for low impact management, nature-based stabilization, or even no stabilization action at all. For areas deemed suitable for no stabilization action, the shoreline should be able to naturally change, stabilize, and protect itself from erosive forces. **The entire shoreline within the interior of the Hampton-Seabrook Estuary salt marsh is best suited for living shorelines and has a low need for structural components** (Figure 18). The coastal shoreline outside of the harbor is best suited for living and hybrid shorelines, while the shoreline area near the harbor's mouth is best suited for hybrid living shorelines with site modification. Examples of hybrid living shoreline designs include vegetated berms, regraded areas, structural sills, engineered cores, and modified hard structures that add habitat value. Structural components used for these techniques include materials such as rocks, coir logs and matting, root wads, shells, and other biodegradable geotextile materials. Site modifications include limbing or cutting trees, grading banks, and adding fill to create continuity between land and water. Mudflat or marsh sites could also benefit from planting tidal wetland plant species along a coir sill or planting understory vegetation within the bordering upland banks to enhance habitat and stabilization. Existing sites that are armored with rip rap or other hard structural elements could be modified to add "functional habitats" by: making breaks in the rip rap to allow aquatic organism passage; incorporating marine-safe concrete or reef balls; fortifying seawalls with vegetated dunes; or maintaining wetlands and upland riparian buffers adjacent to the conventional hard armoring structures. Other living shoreline projects include replanting banks, building fringe salt marsh, or creating dunes along the beach (Balasubramanyam & Howard, 2019).

In addition to living shorelines, **other techniques** are also available to accomplish shoreline stabilization. One example is the placement of semi-permeable barriers seaward of salt marsh edges to reduce wind and wave exposure and aid sediment accretion through the reduction of sediment resuspension. Erosion control devices are cost effective, easily constructed, and biodegradable; however, they often require maintenance and annual reconstruction following winter ice damage (Eberhardt & Burdick, 2008).

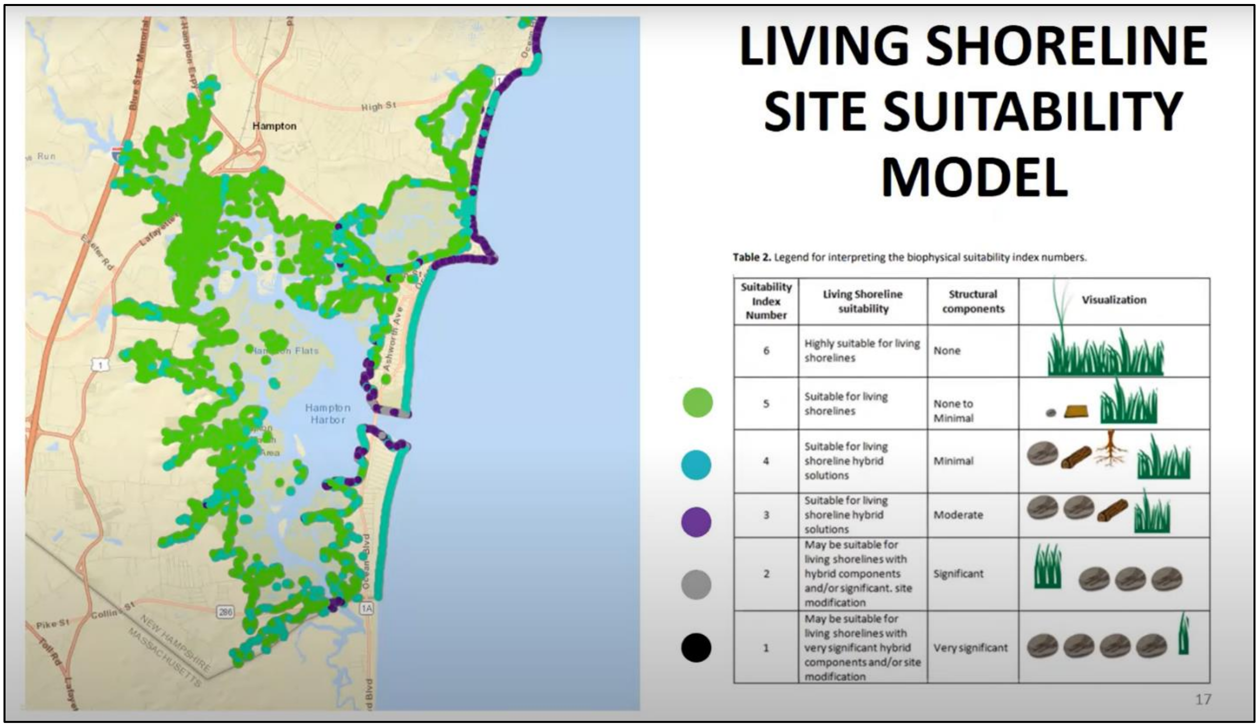


Figure 18. *Living Shoreline Site Suitability Model for the Hampton-Seabrook Estuary's shoreline (Balasubramanyam & Howard, 2019; HSEC, 2021a).*

Land Conservation

Land conservation is essential to the health of a region, particularly for the protection of water resources, enhancement of recreation opportunities, vitality of local economies, and preservation of wildlife habitat. Land conservation is one of many management tools for protecting natural resources for future generations. Local groups should continue to pursue opportunities for land conservation in the Hampton-Seabrook Estuary watershed.

Much work by TNC and NHFG, among several other regional groups, has already been accomplished to identify critical natural resources and habitats in need of conservation in the Hampton-Seabrook Estuary (refer to Conservation Areas for more information). The next step is linking these critical areas with parcels available for purchase and permanent conservation. The HSEC has identified potential conservation opportunities within the Hampton-Seabrook Estuary, including **76 privately-owned parcels and 18 vacant parcels** adjacent to the estuary (Figure 19) (HSEC, 2021b). Key habitat and connective corridors identified in the upper portions of the

'Project of Special Merit' Grant

The NHDES Coastal Program, SHEA, and the Great Bay NERR are teaming up on a proposal to fill gaps in parcel ownership information for the Hampton-Seabrook Estuary. This will be accomplished through deed and title research, as well as policy. The Town of Hampton implements a tax policy whereby salt marsh parcels with no taxes paid on them are turned over to the town. With this tax policy, the Town of Hampton now owns a significant portion of the salt marsh. The towns of Hampton Falls and Seabrook could implement similar tax policies. Identifying parcel owners will allow for more efficient and effective land conservation planning, and well as easier permission requests when accessing the marsh for monitoring or restoration projects.

watershed are also important to protect. The **'Project of Special Merit' Grant** aims to help fill gaps in parcel ownership information for these and other parcels to make land conservation planning more efficient and effective in the future.

Additionally, the watershed towns could adopt a Coastal Watershed Land Conservation Overlay District to allow limited development within CFAs, while still preserving the ecological services provided by them (Zankel, et al., 2006). See the following section on Local Planning & Regulations for related recommendations.

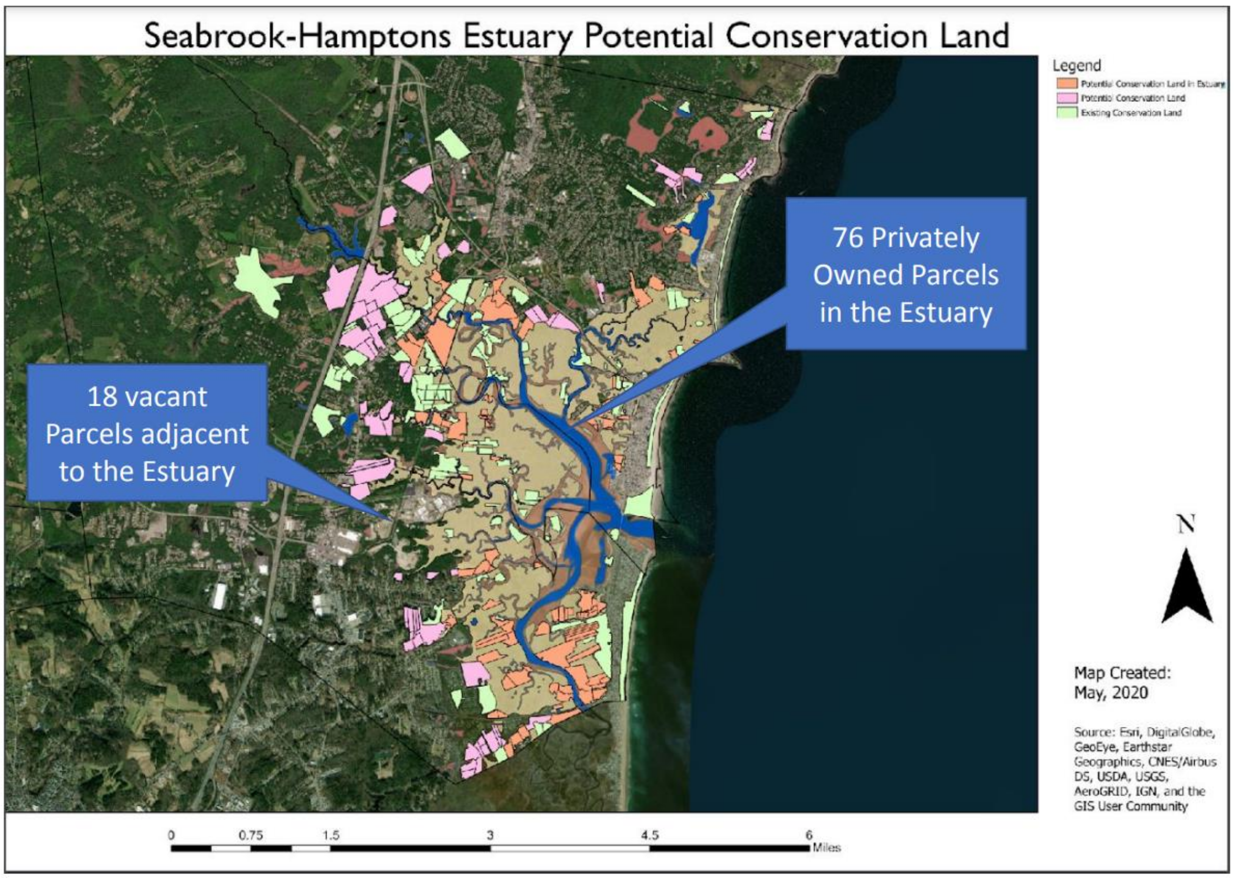


Figure 19. *Parcels with the potential to be conserved in the Hampton-Seabrook Estuary* (HSEC, 2021b)*. Direct link to presentation [here](#).*

Local Planning & Regulations

Regulations through local land use planning and zoning ordinances, such as low impact design strategies that prevent polluted runoff from new and re-development projects in the watershed, are equally important as implementing structural BMPs on existing development. In fact, **local land use planning and zoning ordinances are often the most critical components of watershed protection strategies**. As discussed in the Existing Protection Policies and Regulations section, the three watershed towns (Seabrook, Hampton, and Hampton Falls) have all adopted some level of watershed protection-based regulations and most have several opportunities to adopt additional or more robust regulations to protect natural resources.

The long-term aim is for the three watershed towns to **adopt similar watershed protection regulations so that land use planning and development is consistent across the watershed**. Broad recommendations are provided below. Town-specific recommendations can be found in the Action Plan (Appendix B).

1. **Fully adopt the SWA model stormwater standards** for consistency in stormwater management approaches throughout the watershed (PREP, 2018; UNHSC & RPC, 2012).
2. **Fully incorporate climate change adaptation and mitigation responses into planning, zoning, and permitting**, using 50-year or more planning horizons and assuming 1.5-foot rise in sea level by mid-century and 3 to 5-foot rise in sea level by end of the century (RPC, 2009). For example, elevations for new construction should range from 5 feet for public infrastructure to 4 feet for essential facilities (e.g., schools, hospitals, public safety buildings) to 3 feet for multi-family units and commercial development to 2 feet for single-family homes. See below for more suggestions on incorporating climate change resiliency strategies in planning and regulations.
3. **Use the *NH Coastal Flood Risk Summary Part 2: Guidance for Using Scientific Projections* to require project siting and design to be based on future climate projections** (sea level rise, storm surge, groundwater rise, and precipitation) (NH Coastal Flood Risk Science and Technical Advisory Panel, 2020).
4. **Increase buffers and infrastructure setbacks** near surface waters (PREP, 2015).
5. **Continue partnering with SHEA and the RPC** through the FloodSmart Seacoast Technical Assistance Program to continue the efforts of CHAT in Hampton and to establish a similar group, the Coastal Resilience Team, in Seabrook.
6. **Expand municipal staff resources** to adopt and implement improved watershed protection regulations. Hampton is establishing a Coastal Resilience Coordinator position in 2023.
7. **Identify and include all residents and stakeholders in community planning processes** to ensure input and ownership of shared vision and resources.

Local land use planning and zoning ordinances should consider incorporating climate change resiliency strategies for protecting water quality and improving stormwater infrastructure based on changes in temperature, precipitation, water level, wind load, storm surge, wave height, soil moisture, and groundwater level (Ballestero, Houle, Puls, & Barbu, 2017). There are nine strategies that can aid in minimizing the adverse effects associated with climate change and include the following ((McCormick & Dorworth, 2019).

- **Installing Green Infrastructure and Nature-Based Solutions:** Planning for greener infrastructure requires that we think about creating a network of interconnected natural areas and open spaces needed for groundwater recharge, pollution mitigation, reduced runoff and erosion, and improved air quality.
- **Using Low Impact Development Strategies:** Use of low impact development strategies requires replacing traditional approaches to stormwater management using curbs, pipes, storm drains, gutters, and retention ponds with innovative approaches such as bioretention, vegetated swales, and permeable paving.
- **Minimizing Impervious Surfaces:** Impervious surfaces such as roads, buildings, and parking lots should be minimized by creating new ordinances and building construction design requirements which reduce the imperviousness of new development. Property owners can increase the permeability of their lots by incorporating permeable driveways and walkways.
- **Encouraging Riparian Buffers and Maintaining Floodplains:** Municipal ordinances should forbid construction in floodplains, and in some instances, floodplains should be expanded to increase the land area to accommodate larger rainfall events. Riparian (vegetated) buffers and filter strips along waterways should be preserved and/or created to slow runoff and filter pollutants.
- **Protecting and Re-establishing Wetlands:** Wetlands are increasingly important for preservation because wetlands hold water, reduce flooding, recharge groundwater, and mitigate water pollution.
- **Encouraging Tree Planting:** Trees help manage stormwater by reducing runoff and mitigating erosion along surface waters. Trees also provide critical shading and cooling to streams and land surfaces.
- **Promoting Landscaping Using Native Vegetation:** Landowners should promote the use of native vegetation in landscaping, and landscapers should become familiar with techniques which minimize runoff and the discharge of nutrients into waterbodies (Chase-Rowell, Davis, Hartnett, & Wyzga, 2012).
- **Slowing Down the Flow of Stormwater:** To slow and infiltrate stormwater runoff, roadside ditches can be armored or vegetated and equipped with turnouts, settling basins, check dams, or infiltration catch basins. Rain gardens can retain stormwater, while waterbars can divert water into vegetated areas for infiltration. Water running off roofs can be channeled into infiltration fields and drainage trenches.
- **Coordinating Infrastructure, Housing, and Transportation Planning**: Coordinate planning for infrastructure, housing, and transportation to minimize impacts on natural resources. Critical resources including groundwater must be conserved and remain free of pollutants especially as future droughts may deplete groundwater supplies.

Seabrook as Leader

To minimize the extent of impervious surfaces, the Town of Seabrook has removed all residential and commercial minimal parking requirements. Seabrook is one of only a handful, but growing number, of municipalities across the country that have implemented this zoning reform.

Harbor Operations & Navigation

Ensuring that waters within the Hampton-Seabrook Estuary remain navigable is vital for local economies. Industries that rely on the safe navigation of Hampton Harbor and its connected tributaries include commercial fishing, tourism (e.g., boating, whale watching, recreational fishing, etc.), and federal, state, and local governments (e.g., Coast Guard, NHDES, police, etc.). Two management strategies that help to maintain navigation within estuarine waterbodies include dredging and sediment load reduction.

Overseen by the NHDES Dredge Management Task Force, periodic dredging has been performed within Hampton Harbor in the past by the U.S. Army Corps of Engineers to maintain safe navigation and concurrently assist with the replenishment of Hampton and Seabrook beaches. To minimize the environmental impacts associated with dredging, all operations follow state and federal regulations and are guided by the best available data.

Breach Closing Feasibility Study

The U.S. Army Corps of Engineers is currently pursuing a feasibility study on closing a breach in the middle ground bar in the Blackwater River in the Hampton-Seabrook Estuary. Closing this breach would ensure safe and navigable waters in Hampton Harbor. The feasibility study will likely take several years to complete and will be contingent on the use of the NH Coastal Flood Risk Model, anticipated for public release by January 2024.

Reducing sediment load that necessitates dredging of the harbor in the first place is key to the long-term sustainability of harbor navigation. Much of the sediment load is derived from the estuary and watershed. This sediment load can be reduced by controlling stormwater runoff (see sections on Stormwater Management & Pollutant Reduction Measures and Local Planning & Regulations) and stabilizing shoreline banks (see section on Shoreline Stabilization). More recently, the U.S. Army Corps of Engineers identified the closing of a breach in the middle ground bar of the Blackwater River, which feeds into Hampton Harbor, as important for ensuring safe and navigable waters in the harbor (see **Breach Closing Feasibility Study**).

Shellfish Management

In coastal waters, the key to shellfish management is ensuring that water quality is sufficient to support both the growth and consumption of shellfish. For the Hampton-Seabrook Estuary, primary water quality concerns for shellfish include bacteria (fecal coliform) and chemical contaminants (PAHs, pharmaceuticals, per-fluorinated compounds, flame retardants, etc.). The **NHDES Shellfish Program** routinely monitors water quality, weather conditions, and WWTF sewage discharge events for their impact on shellfish growing areas. NHDES uses this information to assess public health risk from shellfish consumption and sets the closure status of shellfish growing areas accordingly. NHDES also completes regular sanitary surveys to identify possible sources of pollutants to shellfish growing areas. Management strategies to ensure water quality supports shellfishing are the same as the pollutant reduction measures listed in the sections above and include protecting buffers, properly designing and maintaining septic systems, inspecting sewer systems, controlling pet and wildlife waste, and implementing BMPs to control stormwater and agricultural runoff.

In addition to water quality, another threat to shellfish in New England is **predation from the invasive green crab**. The population of green grabs in the Gulf of Maine has been increasing over time due to warming water temperatures that enable their survival through the winter. With shellfish as one of the main sources of food for green crabs, many shellfish communities are collapsing under green crab predation (Pratt-Kielley, 2022). Although the population of green crabs in Hampton Harbor has decreased in recent years, green crabs in the Hampton-Seabrook Estuary remain a threat to the area's clam population (PREP, 2018). To combat this threat, local communities may consider implementing a nursery program to help seed and grow the clam population, similar to what some communities in Maine are working toward (Pratt-Kielley, 2022).

Another threat facing shellfish in the estuary is **sedimentation**. For sessile bivalves such as oysters and mussels, rapid sedimentation can cause mortality if the organisms are smothered for an extended period. Sedimentation can be minimized by reducing sediment loads through management measures listed in the Harbor Operations & Navigation section, which also references other relevant sections. Additionally, oyster restoration efforts can be performed where additional substrate is added to the estuary to encourage oysters to grow vertically within the water column, providing them with safe refuge if sediment were to be deposited on the seafloor (PREP, 2018).

Wildlife Habitat Protection

Salt Marsh Sparrow Conservation

Through their assessment of tidal marsh resiliency and strategic marsh management approaches, the Great Bay NERR identified specific salt marsh areas within the Hampton-Seabrook Estuary where salt marsh sparrow habitat should be prioritized for conservation and/or restoration (shown in yellow in Figure 20). Much of the high priority habitat area is in the upper portions of the marsh surrounding the Taylor and Hampton Falls rivers' confluence with the Hampton River, as well as two areas to the south in Seabrook associated with the Blackwater River and the sand dune habitat intact there. Parcels that are not already conserved within these areas should be prioritized for land conservation efforts. Within conserved parcels in these areas, protective measures should be taken to limit habitat disturbances (e.g., closing off public access to nesting areas).

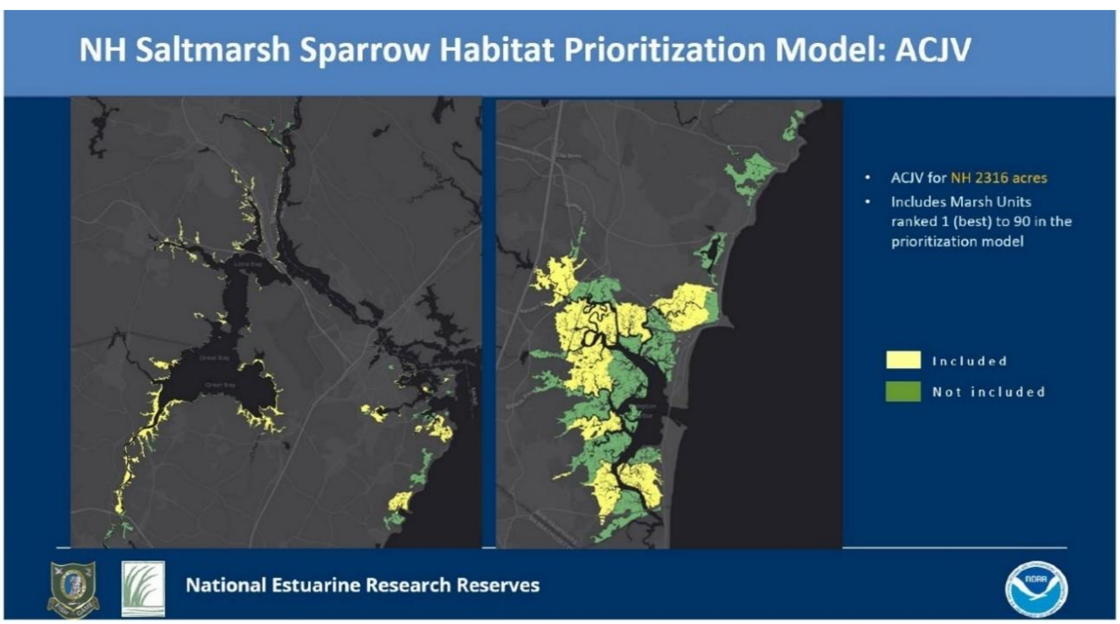


Figure 20. *Salt marsh sparrow habitat prioritization by salt marsh area for New Hampshire's estuaries* (Stevens, Callahan, Carter, & Riley, Draft in Progress). *Yellow areas are high priority for salt marsh sparrow habitat. Green areas are not currently a priority for salt marsh sparrow habitat.*

Fish Passage

Within the Hampton-Seabrook Estuary watershed, there are six primary river systems that provide freshwater to the estuary: Tide Mill Creek and Meadow Pond, Drakes River, Taylor River, Hampton Falls River, Cains Brook and Mill Creek, and Blackwater and Little rivers. These rivers vary in terms of their freshwater and tidal extents, historic and current fish species, and number of dams present (Table 6). In terms of restoring fish passage for diadromous species, the two rivers that present the greatest opportunities are the Taylor River and the Hampton Falls River. Within the Taylor River, there are two dams that limit the ability of fish to access upstream habitat. If the water quality in the impoundment upstream of the dam improved and either fish passage was upgraded or these dams were removed all together, this river would provide excellent fish habitat for spawning as the surrounding land in the upper watershed is listed as a CFA. The Hampton Falls River contains the most dams in the watershed and is therefore one of the most restricted habitats for fish. Despite this restriction, the Hampton Falls River portion of the watershed contains minimal development and would provide excellent spawning habitat if fish passage were improved (Eberhardt & Burdick, 2008). If effective management actions are taken to improve fish passage on these two rivers, then it is likely that spawning populations of river herring and shad will return (PREP, 2018).

Table 6. *The six primary tributary river systems to the Hampton River and Hampton-Seabrook Estuary, including their general location, historic and current fish presence, and number of dams along their reach (Eberhardt & Burdick, 2008).*

Name	Location	Historic Fish Presence	Current Fish Presence	Dams
Tide Mill Creek & Meadow Pond	Hampton/NE portion of watershed	Eels, river herring, shad, and smelt	Eels, river herring, shad, and smelt	2
Drakes River	Hampton/NE portion of watershed	River herring, shad, and eels	Alewives, river herring, rainbow smelt, and shad	4
Taylor River	Kensington, Stratham, Exeter, Hampton, and Hampton Falls	Shad, river herring, smelt, and eels	River herring with remnant populations of shad, smelt, and eels	2
Hampton Falls River	Kensington, Hampton Falls, and Seabrook	Smelt, shad, river herring, and eels	Very low numbers of historic species	8
Cains Brook & Mill Creek	Originates in Salisbury, MA and primarily flows through Seabrook	Smelt, river herring, eels, and shad	Eels, alewives, and smelt	2
Blackwater and Little River	Originates in Salisbury, MA and primarily flows through Seabrook	River herring, shad, and smelt *Only river to potentially support Atlantic sturgeon*	Eels	2

Invasive Plant Species Control

Removing invasive plants in salt marsh environments is a well-established management practice that can be performed using a variety of methods depending on the target species and environmental conditions present. If possible, invasive plant removal can be performed in conjunction with creating low impact access points for recreation in rivers, creeks, and the harbor. In coastal New Hampshire, it is recommended that watershed managers consult the Coastal Watershed Invasive Plant Partnership (CWIPP) before beginning invasive plant removal to receive species-specific treatment recommendations.

Invasive plant removal **methods** relevant to the Hampton-Seabrook Estuary include mowing, burning, and the application of herbicides. **Mowing** is an easy method for invasive plant removal, hindering the growth of the target species while increasing sunlight availability for competing native plants. Downsides to mowing include its labor-intensive nature, annual maintenance schedule, need for managing clippings, and low success rate. As a result, it is recommended that mowing be performed in conjunction with other methods. **Burning** is another plant removal method that works well for large areas of invasive plants but is limited to days when the environmental conditions are favorable and is not effective in removal of perennial invasives. Like mowing, it is recommended that other methods be used in addition to burning. The most effective plant removal tool is **herbicides**, which can kill off invasive plants and allow native plants to grow back in their place. Advantages of herbicides include their easy application and ability to treat both large and small areas. Disadvantages include potential harm to native plants and aquatic organisms from use of broad-spectrum herbicides. NHDES is currently looking to enhance pepperweed management using herbicides, which will require state and local permitting. To ensure that invasive plants do not recolonize the area in the long-term, it is recommended that native salt marsh vegetation be planted after removal is complete, regardless of the method employed (Eberhardt & Burdick, 2008).

Environmental Justice

Climate change disproportionately affects the most vulnerable people within a community, including the elderly, disabled, and impoverished, and the watershed communities of the Hampton-Seabrook Estuary are no exception. **Demographics** for Hampton and Seabrook show that 20% and 27% of the population is over 65 years of age; 10% and 18% of the population is on disability; and 3% and 7% of the population is below the poverty line, respectively. Acknowledging and considering community demographics and their vulnerabilities in climate change adaptation planning at the local, state, and federal levels are critical to protecting all people within a given watershed. The Hampton-Seabrook Estuary is located within EPA's Region 1, which published an ***Environmental Justice Action Plan*** in 2022 with specific recommendations and management strategies for environmental projects engaging with underserved communities (EPA, 2022b). The plan specifically calls out the need to connect with underserved communities to ensure they have a voice and role in improving environmental and health conditions in their area.

As part of a larger study on the *Integrated Analysis of the Value of Wetland Services in Coastal Adaptation* for the Hampton-Seabrook Estuary, a **social impact assessment (SIA)** analyzing the social impacts from climate change was performed for the towns of Hampton, Hampton Falls, and Seabrook (Kirshen, et al., 2018). The SIA relied on the derivation of a social vulnerability index (SVI), which was based on 2011-2015 demographic and socio-economic variables such as age, race, and income for census tracts in the three towns. Tract 65008 in Hampton was identified as the most socially vulnerable to climate change. Tract 63002 in Seabrook was the second-most socially vulnerable. These tracts had high percentages of people over age 65, living below the poverty line, or on disability. Low-income individuals living within flood prone areas may not be able to afford the costs of adaptation fixes to guard their homes against the possibility of flooding or the costs of repairs from damage caused by flooding that already occurred. Both homeowners and renters may also be unable to find affordable housing in other areas if they are forced to relocate away from flood areas. There were some limitations to the SIA that could be addressed by a more refined analysis in the future. Namely, performing the SIA at the census tract scale masked nuances in socio-economic disparities, particularly within Seabrook.

Using EPA's ***Environmental Justice Screening Tool*** for the Hampton-Seabrook Estuary region, wastewater discharge and proximity to a superfund site are identified as threats impacting the highest percentage of the population. Although it is not included as a category within EPA's *Environmental Justice Screening Tool*, coastal flooding is another major threat to the Hampton-Seabrook Estuary region, which could impact the infrastructure related to wastewater discharge and the superfund site. To address the coastal flooding threat, many coastal communities have conducted vulnerability assessments to identify highest priority infrastructure risks due to storm surge and sea level rise. All three towns in the watershed participated in the recently published *Seacoast Transportation Corridor's Vulnerability Assessment and Resiliency Plan* (RPC, 2022) and should consider performing similar risk assessments for non-transportation infrastructure (e.g., municipal buildings, schools, hospitals, etc.). While drafting these assessments, municipalities need to consider the vulnerable populations most impacted by a changing climate. Aging and disabled populations tend to be less able to quickly mobilize during an environmental event and are more likely to require additional assistance. Since access to technology varies throughout a community, it is also important to publish information regarding environmental risks through a variety of media to ensure that vulnerable community members obtain the information in a timely manner.

When faced with coastal flooding, municipalities have the option to either retreat, accommodate, or protect infrastructure located along the coast (as discussed in the Flood Response section). Some municipalities have already outlined their intended plans to address flooding. Hampton wants to preserve the town's economy and sense of place by keeping families in the area and plans to accomplish this by retrofitting at-risk infrastructure to make it more resilient and facilitating a gradual and equitable relocation to higher elevations (Town of Hampton, NH, 2021; Town of Hampton, NH, 2023). In many cases, this relocation will require an economic plan to assist people financially. One potential point of conflict that could arise in the future is the decision to allocate municipal resources toward creating affordable housing or adapting current housing to be more resilient. Environmental issues often co-occur with economic and social issues, and municipalities need to be prepared to address multiple issues at once. Whether it is choosing which structures to protect or assisting in relocation efforts, it is essential that municipalities make decisions and allocate resources in an equitable manner that takes into consideration the needs of its most vulnerable residents.

Public Access

Currently, public access for recreation in the Hampton-Seabrook Estuary is limited. The estuary is primarily surrounded by private land with only a few access points located near busy roads and highways. During a listening session at Winnacunnet High School, students ranked recreational opportunities and viewing platforms to engage with the estuary as a top priority. Public exposure to natural resources can be an effective tool in fostering support for their protection, helping community members develop a connection and sense of ownership to the surrounding environment.

To enhance public access to the estuary, it is recommended that some of the public land in and around the estuary be used to **create improved public access points**. Examples of improvements that can be made include installing small boat launches for canoeing and kayaking, establishing scenic viewpoints from nearby roads, or creating parks that include trails, boardwalks, or elevated platforms that can be used to view the estuary and surrounding salt marsh. As with any alteration to the environment, it is important that all potential impacts to the surrounding ecosystem are taken into consideration before creating new public access points. If public parks or easements are established, it is recommended that rules, signs, and infrastructure be put in place to promote environmental stewardship and leave no trace principles among visitors.

Education & Outreach

Awareness through education and outreach is a critical tool for protecting and restoring natural resources. Most people want to be responsible watershed stewards and not cause harm, but many are unaware of best practices to reduce or eliminate their impact on natural resources. SHEA is the primary entity for education and outreach campaigns in the watershed and for development and implementation of the plan. SHEA and other key watershed protection groups should continue all aspects of their education and outreach strategies and consider developing new ones or improving existing ones to reach more watershed residents. Examples include providing educational materials to existing and new property owners, as well as renters, by distributing them at various locations and through a variety of means, such as websites, newsletters, social media, community events, or community gathering locations. Additionally, SHEA should continue to engage with local stakeholders, conservation commissions, land trusts, municipalities, businesses, and landowners. Educational campaigns should help individuals connect with the vision and goals for the estuary and recognize the importance of these natural resources to their properties, recreation, and livelihoods.

Adaptive Management Approach

An adaptive management approach, to be employed by SHEA, is highly recommended for protecting the Hampton-Seabrook Estuary. Adaptive management enables stakeholders to conduct restoration actions in an iterative manner. Through this management process, restoration actions are taken based on the best available information. Assessment of the outcomes following restoration actions, through continued watershed and water quality monitoring, allows stakeholders to 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 actions. This process enables efficient utilization of available resources through the combination of BMP performance testing and watershed monitoring activities. Adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration actions. Implementation of this approach ensures that restoration actions are implemented and that natural resources are monitored to document restoration over an extended time. The adaptive management components for implementation efforts should include:

- **Maintaining an Organizational Structure for Implementation.** Communication and a centralized organizational structure are imperative to successfully implementing the actions outlined in this plan. A diverse group of stakeholders through SHEA and the HSEC should be assembled to coordinate watershed management actions. Refer to the Plan Oversight section.
- **Establishing a Funding Mechanism.** A long-term funding mechanism should be established to provide financial resources for management actions. In addition to initial implementation costs, consideration should also be given to the type and extent of technical assistance needed to inspect and maintain structural BMPs and other restoration installations. Funding is a key element of sustaining the management process, and, once it is established, the plan can be fully vetted and restoration actions can move forward. A combination of grant funding, private donations, and municipal funding should be used to ensure implementation of the plan. Refer to the Funding Opportunities section.
- **Determining Management Actions.** This plan provides a unified watershed management strategy with prioritized recommendations for restoration using a variety of methods. The

proposed actions in this plan should be used as a starting point for grant proposals. Once a funding mechanism is established, designs for priority restoration actions on a project-area basis can be completed and their implementation scheduled. Refer to the Action Plan (Appendix B).

- **Continuing and Expanding the Community Participation Process.** Plan development has included active involvement of a variety of stakeholders. Plan implementation will require continued and ongoing participation of these stakeholders, as well as additional outreach efforts to expand the circle of participation. Long-term community support and engagement is vital to successfully implement this plan. Continued public awareness and outreach campaigns will aid in securing this engagement. Refer to the sections on Plan Oversight and Education & Outreach.
- **Continuing the Long-Term Monitoring Program.** A monitoring program is necessary to track the health of natural resources in the watershed. Information from the monitoring program will provide feedback on the effectiveness of management practices. Refer to the Monitoring Plan section.
- **Establishing Measurable Milestones.** A restoration schedule that includes milestones for measuring restoration actions and monitoring activities in the watershed is critical to the success of the plan. In addition to monitoring, several environmental, social, and programmatic indicators have been identified to measure plan progress. Refer to the section on Indicators to Measure Progress.

Sunset over the salt marsh. © Carolyn Castiglioni.

Plan Implementation & Evaluation

The following section details the oversight and estimated costs (with funding strategy) needed to implement the action items recommended in the Management Strategies section and Action Plan (Appendix B), as well as the monitoring plan and indicators to measure progress of plan implementation over time.

Plan Oversight

The recommendations of this plan will be **led largely by SHEA with assistance from a diverse stakeholder group**, including representatives from the towns (e.g., select boards, planning boards, and conservation commissions), state and federal agencies or organizations, nonprofits, land trusts, schools and community groups, local business leaders, and landowners. SHEA will need to meet regularly and coordinate resources across stakeholder groups to fund and implement the management actions. The Action Plan (Appendix B) will need to be updated periodically (typically every 2, 5, and 10 years) to ensure progress and to incorporate any changes in watershed activities. Measurable milestones (e.g., number of remediated sites, volunteers, funding received, etc.) should be tracked by SHEA.

The Action Plan (Appendix B) identifies the stakeholder groups responsible for each action item. Generally, the following responsibilities are noted for each key stakeholder:

- **SHEA** will be responsible for plan oversight and implementation. SHEA will facilitate outreach activities, encourage towns and other partners to complete actions, and raise funds for stewardship work.
- **Municipalities** will work to address NPS problems identified in the watershed, including conducting regular best practices maintenance on roads, adopting ordinances for natural resource protection, and addressing other recommended actions specified in the Action Plan (Appendix B). Municipalities will collaborate with SHEA to ensure that pertinent action items in this plan and in each town's respective Master Plan are addressed consistently and simultaneously. For example, the Town of Hampton will establish a Master Plan Implementation Committee to include SHEA representation following adoption of the 2023 Master Plan update.

A Note for Municipalities

Municipal engagement is a critical piece in the successful implementation of this plan. With SHEA's support and guidance in identifying and prioritizing actions and funding opportunities, each town can use this plan to align their community's vision and planning activities with the goals and actions specified herein. The first step that each town can take is to adopt this plan as an addendum to their master plan. The second step is for each town to send one or more representatives to meetings of groups such as CHAT and the HSEC. The third step is for town staff to have at least annual meetings with SHEA to review the status of action items relevant to the town. SHEA plans to give regular presentations to the town boards to keep Hampton-Seabrook Estuary top-of-mind.

- **Conservation Commissions** will work with municipal staff and boards to facilitate the implementation of the recommended actions specified in the Action Plan (Appendix B).
- **NHDES** will provide technical assistance, permit approval, and the opportunity for financial assistance through their funding programs.
- **PREP** will offer technical and financial assistance to SHEA to implement the Action Plan (Appendix B).
- **UNH** will continue to seek out funding for research opportunities that will help guide future estuary management decisions.
- **Private Landowners** will seek opportunities for increased awareness of water quality protection issues and initiatives and conduct activities in a manner that minimizes pollutant impact to surface waters.

The success of this plan is dependent on the continued effort of volunteers and a strong and diverse stakeholder group (such as the HSEC) that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim milestones. Achieving the vision for the estuary is no easy task, and because there are many diffuse sources of pollutants reaching the estuary from existing development, roads, septic systems, and other land uses in the watershed, along with myriad other threats to the estuary's resiliency, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.

Estimated Costs

The strategy for meeting the goals and objectives set for the Hampton-Seabrook Estuary will be dependent on available funding and labor resources but will include approaches that address direct threats to the estuary, as well as monitoring and education and outreach. Important but difficult to quantify strategies include, but are not limited to, revising local ordinances such as setting low impact development requirements on new construction, identifying and replacing malfunctioning septic systems or leaky sewer lines, upgrading WWTFs, remediating salt marsh ditches, and conserving land. With a dedicated stakeholder group in place and with the help of grant or local funding, it is possible to achieve the vision for the estuary in the coming decades. Rough cost estimates by order of magnitude were determined for each action item in the Action Plan (Appendix B). **The cost of successfully implementing the plan is highly variable depending on numerous factors.** SHEA and the HSEC plan to work collectively and diligently to support and assist the communities in identifying and securing grants to support the implementation of EMP action items.

A Note for Municipalities

Municipalities are oftentimes strained to meet the high financial obligations of addressing a multitude of issues important to their communities, with the actions in this EMP representing only a fraction of the issues that municipalities are compelled to address. With that understanding, municipalities are not alone in shouldering the costs of implementing this EMP. In fact, it is expected that SHEA and the HSEC will be able to assist in finding opportunities to financially support the actions of this EMP through numerous grants (see Funding Opportunities). The Action Plan (Appendix B) identifies municipalities as primary or secondary responsible parties for most of the actions because most actions cannot be completed without municipal support or action. It is the hope that this EMP will serve as a jumping off point for building an even stronger and more cohesive watershed-wide stakeholder team that works together to achieve the goals and objectives of this EMP.

Funding Opportunities

It is important that SHEA develop a sustainable funding strategy to implement the recommendations listed in the Action Plan (Appendix B). Funding to cover ordinance revisions and third-party review could be supported by municipalities through tax collection (as approved by majority vote by residents). Monitoring and assessment funding could come from a variety of sources, including state and federal grants, municipalities, or donations. Funding to improve septic systems, roads, and shoreland zone buffers would likely come from property owners. As the plan evolves into the future, the establishment of a funding subcommittee or dedicated paid position such as the HSEC ICC will be a key part in how funds are raised, tracked, and spent to implement and support the plan. Listed below are state and federal funding sources that could assist SHEA and partners with future estuary work.

Funding Options:

- **Inflation Reduction Act** – There are potential yet unknown funding opportunities from federal funds allocated under the Inflation Reduction Act passed by Congress in 2022. SHEA should keep a close watch on funding opportunities made possible from this source.
- **Bipartisan Infrastructure Law (BIL) via PREP** – As part of the federal infrastructure bill, PREP will be receiving $900,000 annually for five years. A portion of those funds are already slated for the HSEC ICC position. PREP plans to provide additional direct funding to SHEA to support continuation of the ICC position. PREP will be expanding estuary monitoring through the Jackson Estuarine Laboratory (JEL) to include an additional monitoring station likely on the Blackwater River, as well as expanding tributary monitoring through the UNH Water Quality Analysis Laboratory (WQAL). PREP will also be doubling the funding allocated to PREPA community grants for the watershed towns.
- **Bipartisan Infrastructure Law (BIL) via NOAA** – As part of the federal infrastructure bill, NOAA received $2.96 billion to administer over the next five years. The five provisions most relevant to the estuary relate to advancing coastal protection, coastal habitat restoration, and resilience (both natural resource and human).
    - Through the **CZM Habitat Protection and Restoration Grants**, NOAA will be offering annually for the next five years $5 million for non-competitive projects (slated for assessing and prioritizing restoration projects) and $35 million for competitive projects awarded to applicants such as the NHDES Coastal Program, who are already prioritizing a $3 million tidal crossings project for this funding, and the Great Bay NERR. Both the NHDES Coastal Program and the Great Bay NERR are using the non-competitive funding to increase program capacities with additional staff to provide more assessment and monitoring work for restoration efforts, including in the Hampton-Seabrook Estuary. https://fundingnaturebasedsolutions.nwf.org/programs/coastal-zone-management-habitat-protection-and-restoration-grants/
    - A portion of the NOAA infrastructure bill monies will go to the **NFWF National Coastal Resilience Fund** ($136 million awarded to 88 projects in 2022), which has been successfully awarded to multiple stakeholders for projects in the Hampton-Seabrook Estuary. https://www.nfwf.org/programs/national-coastal-resilience-fund
    - In 2022, NOAA allocated $85 million in funding for **transformational habitat restoration and coastal resilience projects**, with three-year award amounts per project ranging from $1 million to $15 million.

https://www.fisheries.noaa.gov/grant/transformational-habitat-restoration-and-coastal-resilience-grants

  - In 2022, NOAA allocated $10 million in funding for **coastal habitat restoration and resilience grants** for underserved communities, with three-year award amounts per project ranging from $75,000 to $1 million. https://www.fisheries.noaa.gov/grant/coastal-habitat-restoration-and-resilience-grants-underserved-communities
  - Funds will continue to be available through the **NHDES Coastal Program's Coastal Resilience Grant** (suspended in 2022 but will resume in 2023). https://www.des.nh.gov/business-and-community/loans-and-grants/coastal-resilience-grants

- **Restore America's Estuaries – Coastal Watersheds Grant Program** – Coastal Watershed Grants are available for projects within a National Estuary Program (NEP) planning area. EPA awarded a pass-through grant to Restore America's Estuaries for this competitive national grant program, which awards three to ten projects each year, ranging from $75,000 to $250,000 per project (with about $1 million in funding awarded annually). https://estuaries.org/coastal-watershed-grants/
- **Clean Water State Revolving Fund (NHDES CWSRF)** – This fund provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund NPS pollution prevention, watershed protection and restoration, and water resource management projects that help improve and protect water quality in New Hampshire. This fund has received an influx of federal American Rescue Plan Act (ARPA) funds so that available funding has increased from $75,000 to $100,000 and a portion of loans are converted to grants (requiring no interest). https://www.des.nh.gov/business-and-community/loans-and-grants/clean-water-state-revolving-fund
- **USFWS National Fish Passage Program** – This nationwide program supports dam removals, culvert replacements, and fish ways. Applicants are encouraged to work with USFWS fish biologist Jamie Masterson on project scoping. https://www.fws.gov/program/national-fish-passage
- **USFWS National Coastal Wetlands Conservation Grants** – This program offers grants up to $1 million for protecting, restoring, and enhancing coastal wetlands and associated uplands, including the direct purchase of land for conservation. https://www.fws.gov/service/national-coastal-wetlands-conservation-grants
- **USFWS North American Wetlands Conservation Act Grants** – This program offers 1:1 matching grants for protecting, restoring, and enhancing coastal wetlands and associated uploads, including the direct purchase of land for conservation.https://www.fws.gov/service/north-american-wetlands-conservation-act-nawca-grants-us-standard
- **The Northeast Regional Ocean Council (NROC)** – The NROC is likely funding a regional water level monitoring network for New England. There is potential for funding to be allocated to the Hampton-Seabrook Estuary in continuing and expanding water level monitoring in the estuary.
- **EPA/NHDES 319 Grants (Watershed Assistance Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the NPS Management Program Plan, updated 2019) and protect high quality waters. 319 grants are available for the

implementation of watershed-based plans and typically fund $50,000 to $150,000 projects over the course of two years. https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance

- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)** – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation. The total SCC grant request per application cannot exceed $24,000. https://www.mooseplate.com/grants/
- **Land and Community Heritage Investment Program (LCHIP)** – This grant provides matching funds to help municipalities and nonprofits protect the state's natural, historical, and cultural resources.https://www.lchip.org/index.php/for-applicants/general-overview-schedule-eligibility-and-application-process
- **Aquatic Resource Mitigation Fund (ARM)** – This grant provides funds for projects that protect, restore, or enhance wetlands and streams to compensate for impacted aquatic resources. The fund is managed by the NHDES Wetlands Bureau that oversees the state In-Lieu Fee (ILF) compensatory mitigation program. A permittee can make a payment to NHDES to mitigate or offset losses to natural resources because of a project's impact to the environment. https://www.des.nh.gov/climate-and-sustainability/conservation-mitigation-and-restoration/wetlands-mitigation
- **New England Forest and River Grant (NFWF NEFRG)** – This grant awards $50,000 to $200,000 to projects that restore and sustain healthy forests and rivers through habitat restoration, fish barrier removal, and stream connectivity such as culvert upgrades. https://www.nfwf.org/newengland/Pages/home.aspx
- **Regional Conservation Partnership Program (RCCP)** - This NRCS grant provides conservation assistance to producers and landowners for projects carried out on agricultural land or non-industrial private forest land to achieve conservation benefits and address natural resource challenges. Eligible activities include land management restoration practices, entity-held easements, and public works/watershed conservation activities. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp/
- **Agricultural Conservation Easement Program (ACEP)** - This NRCS grant protects the agricultural viability and related conservation values of eligible land by limiting nonagricultural uses which negatively affect agricultural uses and conservation values, protect grazing uses and related conservation values by restoring or conserving eligible grazing land, and protecting, restoring, and enhancing wetlands on eligible land. Eligible applicants include private landowners of agricultural land, cropland, rangeland, grassland, pastureland, and non-industrial private forestland. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/
- **Conservation Stewardship Program (CSP)** - This NRCS grant helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Eligible lands include private agricultural lands, non-industrial private forestland, farmstead, and associated agricultural lands, and public land that is under control of the applicant. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

- **Environmental Quality Incentives Program (EQIP)** - This NRCS grant provides financial and technical assistance to agricultural producers and non-industrial forest managers to address natural resource concerns and deliver environmental benefits. Eligible applicants include agricultural producers, owners of non-industrial private forestland, water management entities, etc. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
- **National Fish and Wildlife Federation (NFWF) Five Star and Urban Waters Restoration Grants (NFWF 5-Star)** - Grants 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. Eligible projects include wetland, riparian, in-stream and/or coastal habitat restoration; design and construction of green infrastructure BMPs; water quality monitoring/assessment; outreach and education. https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program
- **North American Wetlands Conservation Act (NAWCA) Grants** - The U.S. Standard Grants Program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the U.S. that further the goals of the North American Wetlands Conservation Act (NAWCA). These projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands-associated migratory birds. https://www.fws.gov/service/north-american-wetlands-conservation-act-nawca-grants-us-standard
- **National Park Service - Land and Water Conservation Fund Grant Program (LWCF)** - Eligible projects include acquisition of parkland or conservation land; creation of new parks; renovations to existing parks; and development of trails. Municipalities must have an up-to-date Open Space and Recreation Plan. Trails constructed using grant funds must be ADA-compliant. https://www.nhstateparks.org/about-us/community-recreation/land-water-conservation-fund-grant

Monitoring Plan

A long-term monitoring plan is critical to evaluate both the overall health of the estuary and the effectiveness of implementation efforts over time. The success of this plan cannot be evaluated without ongoing monitoring and assessment and careful tracking of pollutant load reductions or other evaluation criteria following successful restoration projects. PREP (2018) agreed that continuation and expansion of data collection and analysis in the Hampton-Seabrook Estuary “will allow us to better understand the impacts of the many stressors influencing the health of [the] estuary[y], track the impacts of past management actions, and modify future strategies so they are as effective as possible.”

There are multiple objectives for the monitoring plan. One objective is **addressing data gaps with further research and monitoring**, listed in Objective 5.6 of the Action Plan (Appendix B) and largely to be carried out by UNH. A second objective is **establishing a long-term annual baseline monitoring effort of key indicators** (e.g., water quality, water level, fish, shellfish, vegetation mapping, etc.) to consistently track the health of the estuary and its response to plan implementation progress or emerging threats over time. PREP currently monitors oyster and clam populations at one site in Hampton Harbor, mussel tissue for toxic pollution at another site in Hampton Harbor, and discrete and continuous water quality at a third site in Hampton Harbor (starting in 2017 using a UNH-maintained data sonde). Baseline monitoring conducted at Great Bay Estuary stations (and possibly under the same

Quality Assurance Project Plan) should be established at one or more stations in the Hampton-Seabrook Estuary, which will enhance the currently limited analyses for the Hampton-Seabrook Estuary in the PREP *State of Our Estuaries Report*. Funding and staff resources to conduct the expanded baseline monitoring will likely come from PREP and UNH. Finally, a third objective is **tracking and quantifying the potential impact of remediation efforts in reducing pollutant loads or restoring habitat**. SHEA, with technical assistance, will be responsible for tracking and quantifying remediation efforts in the watershed. These statistics can be helpful to present in SHEA's annual reports to inform stakeholders of plan implementation progress.

Indicators to Measure Progress

The following environmental, programmatic, and social indicators derived from the Action Plan (Appendix B), along with the numeric milestones associated with each indicator, will help to quantitatively measure the progress of this plan in meeting the goals and objectives for the Hampton-Seabrook Estuary watershed (Table 7). Indicator milestones were estimated based on best professional judgment and were set at short-term (2024), mid-term (2027), and long-term (2032) targets. Setting milestones allows for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant to ongoing activities. SHEA should review the milestones for each indicator on an ongoing basis to determine if progress is being made, and then determine if the plan needs to be revised because the indicator milestones are not being met by their anticipated target timeframes.

Environmental indicators are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between stressors and environmental conditions. **Programmatic indicators** are indirect measures of watershed protection and restoration activities or programs. **Social indicators** measure changes in social or cultural practices and behavior that lead to implementation of management measures and improvement of environmental conditions. SHEA can set up a central database for tracking these indicators and share with partners to help keep updated and relevant to ongoing activities in the watershed.

Table 7. *Environmental, programmatic, and social indicators for the Hampton-Seabrook Estuary Management Plan derived from the Action Plan (Appendix B). Indicator milestones were estimated based on best professional judgement and were set at short-term (2024), mid-term (2027), and long-term (2032) targets.*

Indicators	Milestones*		
	2024	2027	2032
ENVIRONMENTAL INDICATORS			
Improve water quality conditions to meet state water quality standards in all freshwater and estuarine AUs in the watershed	30% AUs Attaining	50% AUs Attaining	100% AUs Attaining
Increase the percentage of possible acre-days or the number of open acres multiplied by the number of days those acres are open for shellfish harvesting	70%	80%	100%
Sustain or increase healthy populations of shellfish annually (PREP goal)	3 million	4 million	5.5 million
Sustain or increase healthy populations of finfish annually (minimal data, no PREP goal)	TBD	TBD	TBD
Maintain or increase salt marsh sediment surface elevation	TBD	TBD	TBD
Sustain or increase populations of salt marsh sparrow and other birds or species of greatest conservation need	TBD	TBD	TBD
Prevent and/or control the introduction and/or proliferation of invasive species	10% area reduction	50% area reduction	100% area reduction
PROGRAMMATIC INDICATORS			
Amount of funding secured from municipal/private entities, fundraisers, donations, and grants for implementation of the Action Plan	$500,000	$5,000,000	$10,000,000

Indicators	Milestones*		
	2024	2027	2032
Number of NPS sites remediated	10	25	75
Linear feet of buffers improved in the shoreland zone	500	2,000	5,000
Number of recommendations adopted from a marine debris reduction plan for the harbor	2	3	5
Number of watershed/shoreline properties receiving technical assistance for implementation cost sharing	5	25	50
Number of workshops and trainings for stormwater improvements on residential properties (e.g., NHDES Soak Up the Rain NH program)	2	5	10
Number of updated or new ordinances that target natural resource protection	5	10	20
Number of new municipal staff for inspections and enforcement of regulations	1	3	5
Number of voluntary or required septic system inspections (seasonal conversion and property transfer)	20	50	100
Number of septic system or sanitary sewer line/WWTFs upgrades	10	25	50
Number of informational workshops and/or trainings for landowners, municipal staff, and/or developers/landscapers on local ordinances, watershed goals, and/or best practices for road management and winter maintenance	2	10	20
Number of parcels with new conservation easements or number of parcels put into permanent conservation	2	5	15
Number of copies of watershed-based educational materials distributed or posted or articles published	500	750	1,000
Number of new best practices for road management and winter maintenance implemented on public and private roads by the municipalities	5	10	20
Number of best practice design standards for stormwater control measures created and implemented by the watershed municipalities	2	5	10
Number of municipalities fully implementing key aspects of the MS4 program	1	2	4
Number of meetings and/or presentations to municipal staff and/or boards related to the EMP	10	20	50
Number of CNMPs completed or NRCS technical assistance provided for farms in the watershed	1	2	5
Area of salt marsh restored and/or natural uplands protected	TBD	TBD	TBD
Linear feet of salt marsh ditches restored	TBD	TBD	TBD
Number of tidal crossings restored for natural hydrology and fish passage	3	5	10
Area of enhanced or expanded salt marsh sparrow habitat	TBD	TBD	TBD
Number of new research projects in the estuary	2	5	10
Number of years implementing a long-term baseline monitoring program for the estuary	2	5	10
Linear feet of bank stabilized through living shoreline projects	500	2,000	5,000
Area of sand dunes protected and maintained or restored	TBD	TBD	TBD
Area of hydrologic function restored to floodplain areas, buffer zones, groundwater, tidal flow, etc.	TBD	TBD	TBD
Number of public and private access points identified, assessed, and remediated	2	5	10
Number of new bicycle or pedestrian paths created	1	2	3
Number of FEMA's High Water Marks installed	1	2	3
Number of planning documents created or updated with natural resource protections	3	5	10
Cubic yards of dredged material used for beach sand replenishment	200,000	400,000	600,000
Number of new or updated natural resource and wildlife surveys completed	2	4	6
Number of protection services provided to vulnerable populations	1	3	5
Number of natural disasters triggering the successful use of emergency services, particularly for vulnerable populations	1	3	5
Number of affordable, hazard resilient housing for vulnerable populations	TBD	TBD	TBD
SOCIAL INDICATORS			
Number of volunteers participating in educational campaigns, monitoring, or restoration projects	15	25	50
Number of people participating in informational meetings, workshops, trainings, BMP demonstrations, or group septic system pumping	50	200	500
Number of watershed residents installing conservation practices on their property	10	100	200

Indicators	Milestones*		
	2024	2027	2032
Number of municipal DPW staff receiving Green SnowPro training	5	10	20
Number of groups or individuals contributing funds for plan implementation	50	100	200
Number of newly trained water quality and invasive species monitors	1	3	5
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	5%	20%	50%
Number of farmers working with NRCS or BCCD	1	2	5
Number of monthly visitors to the SHEA website	20	50	100
Number of people attending demonstration site walks	20	50	100
Number of people taking printed educational materials, including trail maps	50	100	200
Number of different outreach mediums used	2	5	10
Number of coastal resiliency success stories (both private and public)	10	50	100
Number of towns adopting the EMP into their master plans	3	3	3
Number of partners participating in regular HSEC meetings	15	20	25
Number of SHEA board members	3	5	10
Number of towns participating in CHAT or similar group	1	2	3
Participation of Salisbury, MA as an active partner	10%	50%	100%
Number of people from vulnerable populations utilizing emergency or protection services	TBD	TBD	TBD
Number of liaisons engaging with the town for hazard mitigation and climate resilience planning	2	3	5

**Milestones are cumulative starting at year 1.*

References

Balasubramanyam, V., & Howard, K. (2019). *New Hampshire Living Shoreline Site Suitability Assessment: Technical Report.* Portsmouth, NH: New Hampshire Department of Environmental Services Coastal Program.

Ballestero, T., Houle, J., Puls, T., & Barbu, I. (2017). *Stormwater Management in a Changing Climate. Presented at the NH Lakes Annual Meeting.* Meredith, NH.

Bledzki, L., Bubier, J., Moulton, L., & Kyker-Snowman, T. (2010). Downstream effects of beaver ponds on the water quality of New England first- and second-order streams. *Ecohydrology*, 698-707. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/eco.163

Chase-Rowell, C., Davis, M., Hartnett, K., & Wyzga, M. (2012). Integrated Landscaping: Following Nature's Lead. University of New Hampshire Press.

Chin, T., & Howard, K. (2021). *A Summary of High Tide Flooding Recorded by the Hampton, New Hampshire Tide Gauge: 2013-2020.* New Hampshire Department of Environmental Services Coastal Program. Retrieved from https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-21-15.pdf

Choi, R., Beard, K., Kelsey, K., Leffler, A., Schmutz, J., & Welker, J. (2020). Early goose arrival increases soil nitrogen availability more than an advancing spring in coastal western Alaska. *Ecosystems, 23*, 1309-1324. Retrieved from https://link.springer.com/article/10.1007/s10021-019-00472-9

CWP. (1999). *Watershed Protection Techniques* (1 ed., Vol. 3). Center for Watershed Protection.

Eberhardt, A. L., & Burdick, D. M. (2008). *Hampton-Seabrook Estuary Habitat Restoration Compendium.* PREP Reports & Publications.

EF Design & Planning, L. (2020, October 23). *Audit of Exisiting Land Use Planning & Local Input on Developing a Management Plan for the Hampton Seabrook Estuary.* Retrieved from http://shea4nh.org/wp-content/uploads/2020/12/Audit_Final_Hampton-Seabrook-Estuary-Municipal-Planning-and-Regs_10.23.20.pdf

EF Design & Planning, LLC. (2019). *Flooding in Hampton, NH Situation Assessment.* Seabrook-Hampton Estuary Alliance (SHEA) & NHDES Coastal Program.

EPA. (2016). *Wastewater Technology Fact Sheets.* Retrieved from https://www.epa.gov/septic/wastewater-technology-fact-sheets

EPA. (2022a). *New Hampshire Draft Individual NPDES Permits.* Retrieved from United States Environmental Protection Agency: https://www.epa.gov/npdes-permits/new-hampshire-draft-individual-npdes-permits

EPA. (2022b). Environmental Justice Action Plan. *EPA 502/P-21/001.* United States Environmental Protection Agency. Retrieved from https://www.epa.gov/system/files/documents/2022-09/OLEM-EJ-Action-Plan_9.2022_FINAL-508.pdf

Farrell Strategic Group. (2021). *Seabrook-Hamptons Estuary Alliance Public Visioning Survey Report.*

FEMA. (2022). *Region 1: New Hampshire*. Retrieved from U.S. Department of Homeland Security: Federal Emergency Management Agency: https://www.fema.gov/locations/new%20hampshire

FEMA. (n.d.). *Flood Insurance*. Retrieved from https://www.fema.gov/flood-insurance

GBNERR. (2022, January). A Comprehensive Plan for Resilient Salt Marshes in New Hampshire. PowerPoint Presentation.

Hauer, M., Fussell, E., Mueller, V., Burkett, M., Call, M., Abel, K., . . . Wrathall, D. (2020). Sea-level rise and human migration. *Nature Reviews Earth & Environment*(1), 28-39.

HSEC. (2021a, February 11). *Hampton Seabrook Estuary Collaborative Working Webinar: Getting on the Same Page*. Retrieved from https://www.youtube.com/watch?v=HsVZEqhouJk

HSEC. (2021b, March 18). *Hampton Seabrook Estuary Collaborative Working Webinar: Collaborating on Solutions*. Retrieved from https://www.youtube.com/watch?v=xB3COa6J0b8

Hunt, P. (2020). *Rest and Refuel: Conserving Stopover Sites for Migrating Shorebirds Along the New Hampshire Seacoast.* Concord: New Hampshire Audubon.

IPCC. (2013). *Chapter 12: Long-term Climate Change: Projections, Commitmens, and Irreversibility. In: Climate Change 2013: The Physical Science Basis.* Cambrige University Press, UK and New York, USA. Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter12_FINAL.pdf

Jalbert Leonard, D., Dionne, R., Lucey, K., Mattera, T., & Meaney, C. (2021). *Hampton-Seabrook Estuary Collaborative Prospectus 2021-2022.*

Jones, S. (2000). *New Hampshire Estuaries Project: A Technical Characterization of Estuarine and Coastal New Hampshire.* PREP Publications.

Kirshen, P., Aytur, S., Burdick, D., Foster, T., Lippmann, T., Douglad, E., . . . Watson, C. (2018). Integrated Analysis of the Value of Wetland Services in Coastal Adaptation: Methodology and Case Study of Hampton-Seabrook Estuary, New Hampshire. *Final Report to NOAA, Award #NA14OAR4310194*. Retrieved from https://scholars.unh.edu/cgi/viewcontent.cgi?article=1154&context=jel

Mariash, H., Rautio, M., Mallory, M., & Smith, P. (2019). Experimental tests of water chemistry response to ornithological eutrophication: biological implications in Arctic freshwaters. *Biogeosciences*, 4719-4730. Retrieved from https://search.proquest.com/openview/4f008318d39b55648830d53e4a366062/1?pq-origsite=gscholar&cbl=105740

McCormick, R., & Dorworth, L. (2019). Climate Change: How will you manage stormwater runoff? *FNR-426-W; IISG-10-14*. Purdue Extension. Retrieved from https://www.extension.purdue.edu/extmedia/FNR/FNR-426-W.pdf

McKinley, P., & Hunt, P. (2008). *Avian Use of the Hampton-Seabrook Estuary: 2006-2007.* Concord: New Hampshire Audubon.

Meaney, C. (2022). Advancing Ecosystem and Community Resilience within New Hampshire's Hampton-Seabrook Estuary. Retrieved from https://prepestuaries.org/02/wp-content/uploads/2022/09/Hand-Out-Advancing-Ecosystem-and-Community-Resilience-Hampton-Seabrook-Estuary-FINAL.pdf

Moore, G. E. (n.d.). *Present and Future Strategies for Salt Marsh Resilience in the Hampton-Seabrook Estuary*. Retrieved from PREP Presentations: https://prepestuaries.org/02/wp-content/uploads/2021/06/HSE-Restoration-Techniques_Moore.pdf

Nash, C., & Dejadon, B. (2019). *Sanitary Survey Report For Hampton/Seabrook Harbor, New Hampshire.* Concord: NH Department of Environmental Services.

National Weather Service. (n.d.). *Hydrometeorological Design Studies Center Precipitation Frequency Server (PFDS)*. Retrieved from NOAA Atlas 14 Point Precipitation Frequency Estimates: NH: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=pa

NERRS & NOAA. (2021, March). Marshes in Context: exploring marsh resilience at the landscape scale. *Science & Tools for Coastal Communities Nationwide*. Retrieved from https://www.nerra.org/wp-content/uploads/2021/03/NERRS_NOAA_LandscapeResillience_Report_final.pdf

NH Coastal Flood Risk Science and Technical Advisory Panel. (2020). *New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections.* Durham, NH: University of New Hampshire.

NH Coastal Risk & Hazards Commission. (2016). *NH Coastal Risk and Hazards Final Report.* Retrieved from Preparing New Hampshire for Projected Storm Surge, Sea-Level Rise, and Extreme Precipitation: https://www.nhcrhc.org/wp-content/uploads/2016-CRHC-final-report.pdf

NHDES. (2016). State of New Hampshire Surface Water Quality Regulations, Chapter 1700. New Hampshire Department of Environmental Services. Retrieved from https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf

NHDES. (2019). Resilient Tidal Crossings: An Assessment and Prioritization to Address New Hampshire's Tidal Crossing Infrastructure for Coastal Resilience. *R-WD-19-20*. Portsmouth, NH. Retrieved from https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/2020-01/r-wd-19-20-compiled.pdf

NHDES Coastal Program. (2016). *New Hampshire Inventory of Tidal Shoreline Protection Structures.* New Hampshire Department of Environmental Services.

NHFG. (2015). *New Hampshire Wildlife Action Plan.* Concord, NH: New Hampshire Fish and Game Department.

NOAA. (2022). *Climate Data Online Search.* Retrieved from NOAA National Centers for Environmental Information: https://www.ncei.noaa.gov/cdo-web/search

O'Geen, A., Elkins, R., & Lewis, D. (2006). *Erodibility of Agricultural Soils, with Examples in Lake and Mendocino Counties.* Oakland, CA: Division of Agriculture and Natural Resources, University of California.

Otero, X., De La Peña-Lastra, S., Pérez-Alberti, A., Osorio Ferreira, T., & Huerta-Diaz, M. (2018). Seabird colonies as important global drivers in the nitrogen and phosphorus cycles. *Nature Communications*. Retrieved from https://www.nature.com/articles/s41467-017-02446-8

Pratt-Kielley, E. (2022, December 14). *Volunteers are trying to renew Gouldsboro's clam flats, wiped out by warming waters and green crabs*. Retrieved from Maine Public: https://www.mainepublic.org/environment-and-outdoors/2022-12-14/volunteers-are-trying-to-renew-gouldsboros-clam-flats-wiped-out-by-warming-waters-and-green-crabs

PREP. (2015). *Piscataqua Region Environmental Planning Assessment: Hampton-Seabrook Subwatershed, including Hampton, Hampton Falls, and Seabrook.* PREP: Piscataqua Region Estuaries Partnership.

PREP. (2018). *State of Our Estuaries.* Piscataqua Region Estuaries Partnership.

PREP. (2020). *Piscataqua Region Environmental Planning Assessment (PREPA)*. Retrieved from Piscataqua Region Estuaries Partnership: https://prepestuaries.org/resources/prepa/

PREP. (2022). *Hampton-Seabrook Estuary Collaborative*. Retrieved from Piscataqua Region Estuaries Partnership: https://prepestuaries.org/hampton-seabrook-estuary-collaborative/

RPC. (2009). *Adaptation Strategies to Protect Areas of Increased Risk From Coastal Flooding Due to Climate Change.* Exeter: Rockingham Planning Commission.

RPC. (2015). *Tides to Storms: Preparing for New Hampshire's Future Coast: Assessing Risk and Vulnerability of Coastal Communities to Sea Level Rise and Storm Surge: Town of Hampton, New Hampshire Vulnerability Assessment.* Rockingham Planning Commission.

RPC. (2022). *Seacoast Transportation Corridor: Vulnerability Assessment and Resiliency Plan.* Exeter, NH: Rockingham Planning Commission. Retrieved from https://www.therpc.org/application/files/8216/5064/0313/STCVA_FinalReport_NoAppendices.pdf

SHEA & NHDES Coastal Program. (2020). *CHAT: 2019 Coastal Hazards & Adaptation Team Review.* eabrook-Hampton Estuary Alliance and NH Department of Environmental Services Coastal Program.

SHEA. (2022a). *About SHEA*. Retrieved from Seabrook-Hamptons Estuary Alliance: https://shea4nh.org/about/

SHEA. (2022b). *Coastal Hazard Adaptation Team (CHAT)*. Retrieved from Seabrook-Hamptons Estuary Alliance: https://shea4nh.org/coastal-hazards-adaptation-team-chat/

SLR. (2021). *Hampton New Hampshire 2021 Master Plan Update Coastal Resilience Report.* Town of Hampton.

Smith, S. M., & Warren, R. S. (2012). Vegetation Responses to Tidal Restoration. In *Tidal Marsh Restoration: A Synthesis of Science and Management* (pp. 59-80). Washington, DC: Island Press.

Staley, Z., He, D., Shum, P., Vender, R., & Edge, T. (2018). Foreshore beach sand as a reservoir and source of total phosphorus in Lake Ontario. *Aquatic Ecosystem Health & Management*, 268-275. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/14634988.2018.1505353

Steckler, P., & Brickner-Wood, D. (2019). *Connect the Coast: Linking Wildlife Across New Hampshire's Seacoast and Beyond.* Concord, NH: The Nature Conservancy and the Great Bay Resource Protection Partnership.

Steckler, P., & Ormiston, A. (2021). New Hampshire's Coastal Watershed Conservation Plan, 2021 Update. Concord, NH: The Nature Conservancy. Retrieved from https://connect-protect.org/wp-content/uploads/2022/07/NH-Coastal-Watershed-Conservation-Plan-20210630.pdf

Steckler, P., Glode, J., & Flanagan, S. (2016). *Land Conservation Priorities for the Protection of Coastal Water Resources: A Supplement to The Land Conservation Plan for New Hampshire's Coastal Watersheds.* Concord, NH: The Nature Conservancy.

Stevens, R. A., Callahan, C. B., Carter, H. J., & Riley, C. A. (Draft in Progress). *Strategic Marsh Management in New Hampshire. Assessment of Tidal Marsh Resilience at the Landscape Scale and Guide for its Use in Marsh Management, Restoration, and Conservation.*

Town of Hampton Falls, NH. (2019). *Master Plan.* Town of Hampton Falls.

Town of Hampton, NH. (2021). *DRAFT Exisiting Conditions Analysis.* Town of Hampton, NH.

Town of Hampton, NH. (2022). *Public Access & Conservation Land*. Retrieved from The Town of Hampton New Hampshire: https://www.hamptonnh.gov/397/Public-Access-Conservation-Lands

Town of Hampton, NH. (2023, January 11). DRAFT Our Town, Our Future: Town of Hampton Master Plan. Town of Hampton, New Hampshire.

Town of Seabrook, NH. (2011). *2011-20 Master Plan.* Town of Seabrook NH.

UNHSC & RPC. (2012, December). Model Stormwater Standards for Coastal Watershed Communities. Southeast Watershed Alliance. Retrieved from https://www.unh.edu/unhsc/sites/default/files/media/swa_stormwater-ord.pdf

Wake, C., Knott, J., Lippmann, T., Stampone, M., Ballestero, M., Bjerklie, T., . . . Jacobs, J. (2019). *New Hampshire Coastal Flood Risk Summary – Part I: Science.* Prepared for the New Hampshire Coastal Flood Risk Science and Technical Advisory Panel. Report published by the University of New Hampshire, Durham, NH.

Waterfront Engineers, Inc. (2006). *Cains Brook and Mill Creek Watershed Management Plan, Town of Seabrook.* PREP Reports & Publications.

Weston & Sampson. (2021, July). *Town of Seabrook, NH Wastewater Treatment Facility Climate Resilience Assessment .* Retrieved from https://seabrooknh.info/wp-content/uploads/2021/12/seabrook-wwtf-climate-resilience-assessment-project-report-july-2021.pdf

Wood, M., & Edwardson, K. (2022). *State of New Hampshire 2020/2022 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology.* Concord: New Hampshire Department of Environmental Services. Retrieved from https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf

Zankel, M., Copeland, C., Ingraham, P., Robinson, J., Sinnott, C., Sundquist, D., . . . Alford, J. (2006). *The Land Conservation Plan for New Hampshire's Coastal Watersheds.* Concord, NH: The Nature Conservancy, and Strafford Region Planning Commission. Prepared for the New Hampshire Coastal Program and the New Hampshire Estuaries Project.

Appendices

Appendix A

Table A-1. *Status of applicable water quality parameters for designated uses by NHDES Assessment Units (AU) for the Hampton-Seabrook Estuary watershed. Data taken from draft NHDES 2020 AU list, with parameters containing no data omitted. Parameter Level-NHDES Categories 5-M and 5-P are on the draft NHDES 303(d) list of impaired waters requiring a TMDL. Refer to the NHDES 2020/2022 Surface Water Quality Assessment Viewer for locations of these assessment units in the watershed.*

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
NHEST600031003-01 / HAMPTON FALLS RIVER / 0.0111 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031003-02 / TAYLOR RIVER / 0.0472 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031003-03 / TAYLOR RIVER / 0.0578 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-M
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031003-04 / HAMPTON RIVER BOAT CLUB SZ / 0.0041 sq. mi.	Aquatic Life Integrity	Ammonia (Total)	2-G
		Dissolved oxygen saturation	2-M
		Oxygen, Dissolved	5-P
		pH	2-G
	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Primary Contact Recreation	Chlorophyll-a	3-PAS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	3-PNS
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHIMP600031003-01 / HAMPTON FALLS RIVER III / 2.60 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-02 / HAMPTON FALLS RIVER II / 2.00 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-03 / HAMPTON FALLS RIVER I / 0.18 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-04 / OLD RIVER - CAR BARN POND / 3.98 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-05 / TR DRAKES RIVER / 0.33 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-06 / COFFIN POND DAM - DRAKES RIVER / 1.01 acres	Fish Consumption	Mercury	4A-M

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
NHIMP600031003-07 / DRAKES RIVER - TOWLE FARM DAM / 1.00 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-08 / KENNEY BROOK / 1.00 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-09 / UNNAMED BROOK / 0.56 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-10 / UNNAMED BROOK / 0.98 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-12 / UNNAMED BROOK / 1.75 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-13 / UNNAMED BROOK / 0.77 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-14 / UNNAMED BROOK - SIGNAL COMPANY DAM / 1.91 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-15 / DRAKES RIVER / 0.64 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-16 / DRAKES RIVER / 0.60 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-17 / UNNAMED BROOK - FARM POND / 0.48 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-18 / TR DRAKES BROOK / 0.75 acres	Fish Consumption	Mercury	4A-M
NHIMP600031003-19 / RICE DAM POND - ON TAYLOR RIVER / 1.38 acres	Aquatic Life Integrity	Arsenic	5-M
		Barium	5-M
		Benzo(a)pyrene (PAHs)	5-M
		Benzo[b]fluoranthene	5-M
		Benzo[k]fluoranthene	5-M
		DDE	5-M
		Indeno[1,2,3-cd]pyrene	5-M
		Nickel	5-M
		Zinc	5-M
	Fish Consumption	Mercury	4A-M
NHLAK600031003-01 / BIG DODGE POND / 12.35 acres	Fish Consumption	Mercury	4A-M
NHLAK600031003-02 / TAYLOR RIVER REFUGE POND / 46.52 acres	Aquatic Life Integrity	Anthracene	5-M
		Arsenic	5-M
		Barium	5-M
		Benzo(a)pyrene (PAHs)	5-M
		Benzo[b]fluoranthene	5-M
		Benzo[k]fluoranthene	5-M
		DDD	5-M
		DDE	5-M
		Dissolved oxygen saturation	5-M
		Indeno[1,2,3-cd]pyrene	5-M
		Lead	5-M
		Mercury	5-M
		Nickel	5-M
		Oxygen, Dissolved	5-P
		Zinc	5-M
	Fish Consumption	Mercury	4A-M
NHLAK600031003-03 / MUDDY POND / 2.31 acres	Fish Consumption	Mercury	4A-M
NHRIV600031003-01 / HAMPTON FALLS RIVER - WINKELY BROOK / 11.32 mi.	Aquatic Life Integrity	Aluminum	3-PAS
		Chloride	3-PAS

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
		Copper	3-PAS
		Dissolved oxygen saturation	3-PAS
		Fishes Bioassessments (Streams)	2-M
		Lead	3-PAS
		Oxygen, Dissolved	3-PAS
		Phosphorus (Total)	3-PAS
		Turbidity	3-PAS
		pH	3-PAS
	Fish Consumption	Copper	3-PAS
		Mercury	4A-M
	Potential Drinking Water Supply	Copper	3-PAS
		Escherichia coli	3-PNS
	Primary Contact Recreation	Escherichia coli	3-PNS
	Secondary Contact Recreation	Escherichia coli	3-PNS
NHRIV600031003-02 / HAMPTON FALLS RIVER / 0.04 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-03 / HAMPTON FALLS RIVER / 0.01 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-04 / HAMPTON FALLS RIVER / 0.04 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-05 / TAYLOR RIVER - UNNAMED BROOK / 12.86 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-06 / TAYLOR RIVER - ASH BROOK / 5.62 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-07 / OLD RIVER - TO CAR BARN POND / 2.08 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-08 / OLD RIVER - UNNAMED BROOK / 2.24 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-09 / GRAPEVINE RUN - UNNAMED BROOK / 3.42 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-10 / DRAKES RIVER / 0.32 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-11 / DRAKES RIVER - UNNAMED BROOK / 0.88 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-12 / UNNAMED BROOK / 0.14 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-13 / DRAKES RIVER / 0.26 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-14 / UNNAMED BROOK / 0.13 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-15 / UNNAMED BROOK / 0.19 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-16 / DRAKES RIVER / 0.08 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-17 / UNNAMED BROOK / 0.26 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-18 / KENNEY BROOK - UNNAMED BROOK / 0.68 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-19 / WINKLEY BROOK - UNNAMED BROOK / 1.35 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-20 / UNNAMED BROOK / 1.72 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-21 / CLAY BROOK - UNNAMED BROOK / 1.45 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-22 / UNNAMED BROOK / 0.25 mi.	Fish Consumption	Mercury	4A-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
NHRIV600031003-23 / UNNAMED BROOK / 0.23 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-24 / UNNAMED BROOK / 0.67 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-25 / TAYLOR RIVER - RICE DAM TO TAYLOR RIVER REFUGE POND / 0.10 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031003-26 / UNNAMED TRIB. TO THE TAYLOR RIVER / 0.54 mi.	Fish Consumption	Mercury	4A-M
NHEST600031004-01-02 / HAMPTON FALLS RIVER (WWTF SZ) / 0.0632 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	3-PNS
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-01-03 / HAMPTON FALLS RIVER / 0.0919 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-M
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-02-02 / TAYLOR RIVER (LOWER) / 0.0149 sq. mi.	Aquatic Life Integrity	Aluminum	5-M
	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-M
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-02-03 / BLIND CREEK WWTF SZ / 0.0324 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	3-PNS
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-02-05 / NUDDS CANAL / 0.0343 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	3-PNS
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-03-03 / TIDE MILL CREEK / 0.1214 sq. mi.	Aquatic Life Integrity	Chlorine, Residual (Chlorine Demand)	3-PAS
	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Primary Contact Recreation	Enterococcus	3-PNS
	Secondary Contact Recreation	Enterococcus	3-PAS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	3-PNS

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-04-01 / HAMPTON RIVER WWTF SZ / 0.1538 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	3-PNS
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-05-01 / BROWNS RIVER (LOWER) / 0.0265 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-05-02 / BACK CREEK / 0.0070 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-05-03 / SWAINS CREEK / 0.0253 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PAS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-05-04 / BROWNS RIVER (UPPER) / 0.0446 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-06-01 / HUNTS ISLAND CREEK (LOWER) / 0.0102 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-06-02 / HUNTS ISLAND CREEK (UPPER) / 0.0287 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
NHEST600031004-07 / MILL CREEK / 0.0650 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Primary Contact Recreation	Enterococcus	4A-P
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-08-04 / BLACKWATER RIVER / 0.3092 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Primary Contact Recreation	Enterococcus	4A-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-08-05 / BLOOD CREEK / 0.0148 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PAS
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-09-05 / HAMPTON/SEABROOK HARBOR - SEABROOK HARBOR BEACH / 0.0057 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Primary Contact Recreation	Enterococcus	2-M
	Secondary Contact Recreation	Enterococcus	2-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-09-06 / HAMPTON/SEABROOK HARBOR - HAMPTON HARBOR BEACH / 0.0003 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Primary Contact Recreation	Enterococcus	2-M
	Secondary Contact Recreation	Enterococcus	5-P
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-09-07 / FISH COOP 150 FT SZ / 0.0058 sq. mi.	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-09-08 / HAMPTON RIVER MARINA SZ / 0.1463 sq. mi.	Fish Consumption	Mercury	5-M

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Primary Contact Recreation	Enterococcus	4A-M
	Secondary Contact Recreation	Enterococcus	4A-M
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHEST600031004-09-09 / HAMPTON/SEABROOK HARBOR / 0.6148 sq. mi.	Aquatic Life Integrity	Aluminum	5-M
		DDD	5-M
		Dieldrin	5-M
		Lindane	5-M
		trans-Nonachlor	5-M
	Fish Consumption	Mercury	5-M
		Polychlorinated biphenyls	5-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
	Primary Contact Recreation	Enterococcus	3-PNS
	Secondary Contact Recreation	Enterococcus	2-G
	Shellfish Consumption	Dioxin (including 2,3,7,8-TCDD)	5-M
		Fecal Coliform	4A-P
		Mercury	5-M
		Polychlorinated biphenyls	5-M
NHIMP600031004-02 / LITTLE RIVER / 0.26 acres	Fish Consumption	Mercury	4A-M
NHIMP600031004-03 / UNNAMED BROOK - STEVENS RECREATION POND DAM / 0.08 acres	Fish Consumption	Mercury	4A-M
NHIMP600031004-04 / SECORD POND DAM / 2.50 acres	Aquatic Life Integrity	Sedimentation/Siltation	4C-P
		pH	5-M
	Fish Consumption	Mercury	4A-M
NHIMP600031004-05 / CAINS BROOK / 2.40 acres	Aquatic Life Integrity	Oxygen, Dissolved	5-P
		pH	5-M
	Fish Consumption	Mercury	4A-M
	Secondary Contact Recreation	Sedimentation/Siltation	3-PAS
NHIMP600031004-06 / CAINS BROOK - NOYES POND / 0.90 acres	Aquatic Life Integrity	Chloride	5-M
		Dissolved oxygen saturation	5-P
		Oxygen, Dissolved	5-P
		pH	5-M
	Fish Consumption	Mercury	4A-M
	Primary Contact Recreation	Escherichia coli	4A-M
NHIMP600031004-07 / MARYS BROOK - MARYS POND DAM / 0.92 acres	Fish Consumption	Mercury	4A-M
NHIMP600031004-08 / NILUS BROOK / 1.03 acres	Fish Consumption	Mercury	4A-M
NHIMP600031004-09 / OLD MILLPOND / 5.12 acres	Fish Consumption	Mercury	4A-M
NHIMP600031004-10 / TRIB TO HAMPTON HARBOR / 0.90 acres	Fish Consumption	Mercury	4A-M
NHLAK600031004-01 / MEADOW POND / 46.84 acres	Fish Consumption	Mercury	4A-M
NHRIV600031004-02 / LITTLE RIVER / 0.05 mi.	Fish Consumption	Mercury	4A-M

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
NHRIV600031004-05 / NILUS BROOK - THRU LAMPREY POND / 1.02 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-06 / TIDE MILL CREEK / 0.09 mi.	Fish Consumption	Mercury	4A-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
NHRIV600031004-07 / BROWNS RIVER / 1.40 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-08 / FARM BROOK / 0.86 mi.	Fish Consumption	Mercury	4A-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
NHRIV600031004-09 / FOLLY MILL BROOK / 0.13 mi.	Aquatic Life Integrity	Iron	5-P
		Sedimentation/Siltation	4C-P
		pH	5-M
	Fish Consumption	Mercury	4A-M
NHRIV600031004-10 / CAINS BROOK - UNNAMED BROOK / 2.22 mi.	Aquatic Life Integrity	pH	5-M
	Fish Consumption	Mercury	4A-M
	Primary Contact Recreation	Escherichia coli	4A-P
	Secondary Contact Recreation	Escherichia coli	4A-M
NHRIV600031004-11 / CAINS BROOK / 0.03 mi.	Aquatic Life Integrity	pH	5-M
	Fish Consumption	Mercury	4A-M
NHRIV600031004-12 / CAINS BROOK / 0.25 mi.	Fish Consumption	Mercury	4A-M
	Primary Contact Recreation	Escherichia coli	4A-P
	Secondary Contact Recreation	Escherichia coli	4A-M
NHRIV600031004-13 / UNNAMED BROOK - TO MORRILS CREEK / 0.32 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-14 / UNNAMED BROOK / 1.48 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-17 / MARYS BROOK / 0.46 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-18 / NILUS BROOK / 0.53 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-19 / UNNAMED BROOK / 0.05 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-20 / UNNAMED BROOK / 0.25 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-21 / UNNAMED BROOK - TO CAINS MILL POND / 0.42 mi.	Fish Consumption	Mercury	4A-M
	Primary Contact Recreation	Escherichia coli	4A-P
	Secondary Contact Recreation	Escherichia coli	4A-P
NHRIV600031004-25 / UNNAMED BROOK / 0.10 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-26 / UNNAMED BROOK / 0.41 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-27 / UNNAMED BROOK / 0.55 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-28 / UNNAMED BROOK / 0.27 mi.	Fish Consumption	Mercury	4A-M
NHRIV600031004-29 / UNNAMED BROOK / 1.22 mi.	Fish Consumption	Mercury	4A-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS
NHRIV600031004-33 / UNNAMED BROOK / 0.62 mi.	Fish Consumption	Mercury	4A-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS

Assessment Unit ID / Name / Size	Designated Use	Parameter Name	Parameter Level NHDES Category
NHRIV600031004-34 / UNNAMED BROOK / 0.49 mi.	Fish Consumption	Mercury	4A-M
	Potential Drinking Water Supply	Fecal Coliform	3-PNS

2-G	All samples for a given parameter meet water quality standards by a relatively large margin.
2-M	All samples for a given parameter meet water quality standards, but only marginally.
3-PAS	There is some but insufficient data to assess the parameter per the CALM, however, the data that is available suggests that the parameter is Potentially Attaining Standards (PAS).
3-PNS	There is some but insufficient data to assess the parameter per the CALM, however, the data that is available suggests that the parameter is Potentially Not Supporting (PNS) water quality standards (e.g., there is one exceedance).
4A-M	The parameter is a pollutant which is assessed as an impairment per the CALM, and an EPA-approved TMDL has been completed, however, the impairment is relatively slight or marginal.
5-M	Parameter is a pollutant that requires a TMDL, however, the impairment is marginal.
4A-P	The parameter is a pollutant which is assessed as an impairment per the CALM, and an EPA-approved TMDL has been completed, however, the impairment is more severe and causes poor water quality conditions.
4C-P	Parameter is not a pollutant but is causing impairment per the CALM, and the impairment is more severe and causes poor water quality conditions.
5-P	Parameter is a pollutant that requires a TMDL, and the impairment is more severe and causes poor water quality.

Appendix B

Table B-1. *Action Plan.* ***Goal #*** *and Objective* ***(Obj) #*** *correspond to those listed in the Goals & Objectives section. For each goal and objective, there are several* ***action****s and their* ***source****(s), if applicable to a project-specific document. The* ***timeline*** *for each action is marked with an X in three intervals (****2024, 2027****, and* ***2032****). Ongoing or long-term actions have all three intervals marked. The estimated* ***(est.) cost*** *range for each action is represented by three symbols:* ***$*** *<$100,000,* ***$$*** *>$100,000 to <$500,000, and* ***$$$*** *>$500,000. Each action is also associated with a major categorial* ***project type****, along with identified responsible parties:* ***project lead*** *and* ***partners****.* ***Priority*** *action items are marked with an X and represent actions that the Technical Advisory Committee identified as high priority for the estuary.*

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION					
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 1	1.1	1.1-1	Plan for and implement capital improvements, BMPs, and improved operation and maintenance procedures for stormwater infrastructure, especially infrastructure that is vulnerable to climate change impacts or infrastructure that is negatively impacting water quality. For example, improve stormwater drainage along Kings Hwy, Green St, Gentian Rd, and Meadow Pond Rd in Hampton.	Hampton Master Plan (2023)	X	X	X	$$$	Structural BMPs	Towns		
Goal 1	1.1	1.1-2	Implement recommended actions from the Cains Brook/Tide Mill Creek Watershed Management Plan and apply recommendations to other small watersheds as appropriate.	Seabrook Master Plan (2011)			X	$$$	Structural BMPs	Towns	Towns	
Goal 1	1.1	1.1-3	Provide technical assistance and/or implementation cost sharing to private landowners to install stormwater and/or erosion controls or buffer enhancements throughout the watershed, most especially along marsh fringes.			X		$	Structural BMPs	SHEA	Towns, DES	
Goal 1	1.1	1.1-4	Implement low impact development and green infrastructure on new and existing development. Develop best practice design standards for stormwater control measures. See Objective 5.1.	Hampton Master Plan (2023)		X		$$	Structural BMPs	Towns		X
Goal 1	1.1	1.1-5	Review practices for road and drainage maintenance currently used for each town and determine areas for improvement. Develop and/or update a written protocol for road maintenance best practices. Provide education and training to contractors and municipal staff on protocols for road maintenance best practices.			X		$	Maintenance Practices; Education and Outreach	SHEA	Towns	
Goal 1	1.1	1.1-6	Participate in Green SnowPro training. Become Green SnowPro Certified once program rules for municipalities have been adopted by the Joint Legislative Committee on Administrative Rules. Review and update winter operations procedures to be consistent with Green SnowPro best management practices for winter road, parking lot, and sidewalk maintenance.			X		$	Maintenance Practices; Education and Outreach	SHEA	Towns	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 1	1.1	1.1-7	Hold informational workshops on proper road management and winter maintenance and provide educational materials for homeowners about winter maintenance and sand/salt application for driveways and walkways.			X		$	Maintenance Practices; Education and Outreach	SHEA	Towns	
Goal 1	1.1	1.1-8	Incorporate water quality considerations and strategies into town roadway evaluations and action plans.			X		N/A	Planning & Assessment	Towns		
Goal 1	1.1	1.1-9	Review and optimize MS4 compliance for all towns (regardless of MS4 designation), including infrastructure mapping, erosion and sediment controls, illicit discharge programs, and good housekeeping practices. Sweep municipal paved roads and parking lots two times per year (spring and fall).			X	X	$$	Maintenance Practices; Education and Outreach	Towns		X
Goal 1	1.1	1.1-10	Adopt policies to either eliminate fertilizer applications on town properties or implement best practices for fertilizer management (to minimize application and transport of phosphorus). Consider extending these regulations to private properties as well.			X	X	$	Ordinances, Policies, & Regulations	Towns		
Goal 1	1.1	1.1-11	Work with NRCS to encourage farmers to employ BMPs for fertilizers, pesticides, and manure storage by providing technical assistance, financial assistance, other incentives, and educational outreach through workshops and trainings.	Hampton Falls Master Plan (2019)		X	X	$$$	Agricultural BMPs	NRCS	Farmers	
Goal 1	1.1	1.1-12	Develop a sustainable asset management program to periodically evaluate and upgrade the sanitary sewer system to reduce leaks and overflows, especially near waterbodies.	Hampton Master Plan (2023)	X	X	X	$$$	Wastewater Management	Towns		
Goal 1	1.1	1.1-13	Implement recommendations in the 2021 Town of Seabrook WWTF Climate Resilience Assessment to combat flooding issues and extend the useful life of the existing WWTF. Begin planning for a new Seabrook WWTF positioned at a new upland location by 2050.	Town of Seabrook WWTF Climate Resilience Assessment (2021)	X	X	X	$$$	Wastewater Management	Town of Seabrook		
Goal 1	1.1	1.1-14	Enhance nitrogen removal capacity at the Seabrook and Hampton Wastewater Treatment Facilities.				X	$$$	Wastewater Management	Towns		
Goal 1	1.1	1.1-15	Develop and enforce septic system regulations that require current best practices and technology for the siting, design, and long-term maintenance of septic systems in the watershed. Consider requiring advanced nutrient treatment systems in environmentally sensitive areas. Consider sea level rise and other climate change impacts in siting and design. Consider a minimum pump-out/inspection interval (e.g., once every 3-5 years). Develop and maintain a septic system database for the watershed to facilitate code enforcement. Consider requiring septic system inspection for all home expansions or property sales. Distribute			X		$	Wastewater Management; Education and Outreach	Towns (largely Hampton and Hampton Falls)		X

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
			educational materials to property owners about septic system function and maintenance.									
Goal 1	1.1	1.1-16	Promote boater education related to proper waste disposal methods, spill prevention and clean up, environmentally sensitive maintenance activities (paint and hull scrapings), marine animal observation safety, and marine debris reduction. Minimize overboard boat discharges at the marina or in the harbor.		X	X	X	$	Education and Outreach	Towns		
Goal 1	1.1	1.1-17	Review and improve the environmental sustainability of harbor operations related to the handling of hazardous waste, marine debris, and human wastewater. Develop and implement a marine debris reduction plan for the estuary and harbor.		X	X	X	$$	Harbor Operations; Planning & Assessment	Towns		
Goal 1	1.1	1.1-18	Reduce pet waste entering tributaries and the estuary through town ordinance and education (e.g., signage at key dog walking areas, hand-outs at time of annual dog registrations, waste bags and receptacles).		X			$	Ordinances, Policies, & Regulations; Education and Outreach	Towns	Seacoast Stormwater Coalition	
Goal 1	1.2	1.2-1	Re-evaluate and implement restoration opportunities identified in the HSE Restoration Compendium (2008)	HSE Restoration Compendium (2008)	X	X	X	$$$	Planning & Assessment; Restoration	SHEA	Towns, Property Owners	
Goal 1	1.2	1.2-2	a) Maintain, restore, or increase the area and resiliency of critical natural systems such as saltmarshes to ensure greater protection from storm surge and long-term impacts of sea level rise. b) Implement best management options for enhancing tidal marsh resiliency based on the marsh type and their resiliency category according to the New Hampshire Plan for Resilient Salt Marshes. c) Prioritize saltmarsh restoration and/or natural upland protection in the northeastern portion of the marsh above Route 101, the northwestern corner of the marsh near Drakeside Rd for the protection of critical shorebird species, and two critical foraging and roosting pools in the north marsh area. d) Utilize SMARTeams to facilitate the development of conceptual salt marsh restoration designs.	Seabrook Master Plan (2011); NH Plan for Resilient Salt Marshes (GBNERR, 2022); Hunt (2020); HSE Commons; Hampton Master Plan (2023); Ph I HSE Conservation Project (McKinley and Hunt, 2008)	X	X	X	$$$	Planning & Assessment; Restoration; Conservation	SHEA	Towns, DES, Property Owners	
Goal 1	1.2	1.2-3	Implement a pilot study for a holistic management approach that includes fixing hydrology (ditch remediation and runnels), enhancing sediment supply (thin layer addition, mud motor), and promoting sparrow habitat.	HSE Commons		X		$$	Restoration	SHEA	Towns, DES, Property Owners	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION					
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 1	1.2	1.2-4	Convene a project team, recruit grant funding, identify candidate sites, and conduct design and permitting for a selected site, and implement a ditch remediation demonstration project. Include long term monitoring and strong public communication.	Prospectus (Jalbert Leonard et al., 2021)		X		$$	Planning & Assessment; Restoration; Monitoring; Education and Outreach	SHEA	Towns, DES, Property Owners	
Goal 1	1.2	1.2-5	Remediate legacy ditching throughout the HSE to restore natural hydrology and key habitat. See Objective 2.5.				X	$$$	Restoration	DES	Towns	X
Goal 1	1.2	1.2-6	Remove barriers to fish passage and improve aquatic habitat where possible. Barriers include active or remnant dams or culvert constrictions.				X	$$$	Restoration	SHEA	Towns, DES, NHFG	X
Goal 1	1.3	1.3-1	Evaluate the extent and distribution of invasive species of plants, insects, and animals in the watershed towns, including but not limited to Phragmites, Pepperweed, Japanese Knotweed, Purple Loosestrife, and Japanese Shore Crab.	Hampton Master Plan (2023)	X			$	Planning & Assessment	SHEA	Towns	
Goal 1	1.3	1.3-2	Continue educational and outreach efforts to increase awareness of the negative effects of invasive species.	Hampton Master Plan (2023)	X	X	X	$	Education and Outreach	Towns		
Goal 1	1.3	1.3-3	Control the expansion of phragmites populations as part of salt marsh restoration. See Objective 1.2.	Hampton Master Plan (2023)	X	X	X	N/A	Restoration; Invasive Management	Towns	DES	
Goal 1	1.3	1.3-4	Procure permits and permissions to use herbicide treatment on two Pepperweed sites in the HSE.	HSE Commons	X			$	Restoration; Invasive Management	Towns	DES	
Goal 1	1.4	1.4-1	Convene one or several (regular) meetings with key partners to discuss planning, data needs, and collaboration to address saltmarsh sparrow conservation needs. Explore how best to develop public messaging around sparrow conservation and other benefits provided by marshes.	Prospectus (Jalbert Leonard et al., 2021)	X			N/A	Education and Outreach; Planning & Assessment	NHFG, USFWS, GBNERR	SHEA, UNH, Audubon, PREP	
Goal 1	1.4	1.4-2	Collaborate to develop and use high resolution habitat data and condition indicators to map areas that the sparrows might like and identify areas where marsh could exist in the future in order to prioritize those areas for protection or restoration. Contact Mitch Hartley (ACJV/USFWS), Pam Hunt (NH Audubon), Adrienne Kovach (UNH), and Rachel Stevens (GBNERR).	Prospectus (Jalbert Leonard et al., 2021)	X			$	Planning & Assessment	NHFG, USFWS, GBNERR	SHEA, UNH, Audubon	
Goal 1	1.4	1.4-3	Increase the overall percentage of sparrow breeding success through habitat management. See Objectives 1.2 and 5.2. Develop an evidence-based list of tips for restoration practitioners to include ways to enhance saltmarsh sparrow habitat. Increase knowledge of important submarsh habitat to avoid conflicts.	HSE Collaborative (various presentations, meeting minutes)		X		$	Restoration; Education and Outreach	NHFG, USFWS, GBNERR	SHEA, UNH, Audubon,	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 1	1.4	1.4-4	Refine shorebird population estimates to qualify HSE as a site of regional importance for the Western Hemisphere Shorebird Reserve Network.	Ph I HSE Conservation Project (McKinley and Hunt, 2008)		X		$$	Monitoring	NHFG, USFWS, GBNERR	SHEA, UNH, Audubon	
Goal 1	1.4	1.4-5	Make improvements to the following disturbance-related threats impacting shorebirds: beach driving, dogs, direct harassment, beach raking, coastal engineering, and general beachgoing. Much of this is related to public awareness, outreach, and signage.	Hunt (2020)	X			$	Ordinances, Policies, & Regulations; Education and Outreach	Towns	SHEA, Audubon, Hampton Beach State Park, DNCR, NHFG, USFWS	
Goal 1	1.4	1.4-6	Conduct periodic shorebird monitoring to identify changes in use patterns, including new or shifting roosts, and impacts of human disturbance or other threats.	Hunt (2020)	X		X	$	Monitoring	Audubon	NHFG, SHEA, UNH, USFWS, GBNERR	
Goal 2	2.1	2.1-1	Prioritize and implement bank stabilization through living shorelines at sites identified in the NH Living Shoreline Site Suitability Assessment (2019).	HSE Commons	X	X	X	$$$	Structural BMPs	Towns	DES, Other Property Owners	X
Goal 2	2.1	2.1-2	Employ BMPs for new or existing shoreline development such as bank stabilization techniques and vegetation restoration (i.e., living shorelines) as alternatives to shoreline hardening.	Seabrook Master Plan (2011); Hampton Master Plan (2023)	X	X	X	$$$	Structural BMPs	Towns	DES, Other Property Owners	X
Goal 2	2.1	2.1-3	Continue the active presence of the NH Department of Safety's Marine Patrol in Hampton Harbor to control jet ski activity and minimize bank erosion from wave action.		X	X	X	Ongoing	Enforcement	DOS Marine Patrol		
Goal 2	2.2	2.2-1	Identify and restore key migration areas to a natural buffer condition. See Objective 5.2 and the NH Plan for Resilient Salt Marshes for potential sites.	Hampton Master Plan (2023)	X	X	X	$$$	Restoration	Towns	DES, Other Property Owners	X
Goal 2	2.2	2.2-2	Conserve existing natural buffer areas. See Objective 5.2 and the NH Plan for Resilient Salt Marshes for potential sites.	Hampton Master Plan (2023)	X	X	X	$$$	Conservation	Towns	Other Property Owners	X
Goal 2	2.3	2.3-1	Evaluate and apply sediment application techniques (e.g., tld, mud motor, sediment injection), where feasible, to maintain tidal marsh systems.	Preparing NH (NH Coastal Risk and Hazards Commission, 2016); Hampton Master Plan (2023)	X	X	X	$$$	Restoration	Towns	DES	
Goal 2	2.3	2.3-2	Continue and expand long-term Sediment Elevation Table (SET) monitoring to track changes in salt marsh sediment surface elevation over time. See Objective 5.6.		X	X	X	$$	Monitoring	UNH		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 2	2.4	2.4-2	Continue dune management in Seabrook and Hampton to identify vulnerable dune areas and best options for protecting and enhancing dunes. Options include renourishing sand from dredged sources, planting beach grass or shrubs, erecting fencing, and defining dune paths to corral foot traffic.			X		$$$	Dune Management	UNH Sea Grant Coastal Habitat Restoration Team	Coastal Research Volunteers, Towns	
Goal 2	2.5	2.5-1	Incorporate high priority tidal crossings into town planning documents to target funding for eventual replacement. Work with partners to advance moderate and high priority tidal crossings through feasibility, engineering, permitting, and construction.	Resilient Tidal Crossings (NHDES, 2019)			X	$$$	Planning & Assessment; Restoration; Structural BMPs	Towns		X
Goal 2	2.5	2.5-2	Remediate legacy ditching. See Objectives 1.2-4 and 1.2-5.	Hampton Master Plan (2023)			X	$$$	Restoration	Towns	DES	
Goal 3	3.1	3.1-1	Continue to support and implement the NH Shellfish Program, which includes water quality monitoring and sanitary shoreline surveys.		X	X	X	N/A	Monitoring; Planning & Assessment	Towns	DES	X
Goal 3	3.1	3.1-2	Continue to document the water quality impacts of rainfall events in the 1 to 1.5 inch range, as well as larger storms, to maintain updated information for the evaluation of the 1-inch rainfall closure threshold for Hampton Harbor.	Sanitary Survey Report for Hampton/Seabrook Harbor, NH (Nash & Dejadon, 2019)	X	X	X	N/A	Monitoring	Towns	DES	X
Goal 3	3.1	3.1-3	Develop a shellfish management plan that details use of BMPs for restoring and maintaining sustainable shellfish populations for aquaculture, recreational, and commercial harvesting in HSE.		X			$	Planning & Assessment	Towns	SHEA, DES	
Goal 3	3.2	3.2-1	See Objectives 1.1, 3.3, and 4.1-4.5.									
Goal 3	3.2	3.2-2	Minimize residential dumping in the saltmarsh through public outreach and programs including enhanced leaf and yard waste collection, spring clean-up, and hazardous waste collection.		X	X	X	$$$	Education and Outreach	Towns		
Goal 3	3.3	3.3-1	Identify and assess the condition of all public access points in the watershed. Prioritize remediation of access points that need improvement. For example, the Hampton Falls Depot Rd access point.		X			$$	Planning & Assessment; Structural BMPs; Public Access	SHEA	Towns	
Goal 3	3.3	3.3-2	Install information kiosks at highly trafficked access points. Post helpful information about the estuary and its value. Encourage people to be mindful of not disturbing wildlife, particularly shorebirds.		X	X		$	Education and Outreach; Public Access	SHEA	Towns	X
Goal 3	3.3	3.3-3	Create and publish a public trail and access point watershed map to post at kiosks and the SHEA website. Include types of seasonal trail use, including walking/jogging, horseback riding, bicycling, ATVing or motorbiking, snowmobiling, etc.	Hampton Master Plan (2023)	X			$	Education and Outreach; Public Access	SHEA	Towns	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 3	3.3	3.3-4	Expand or enhance public trails, access points, and scenic viewing locations. For example, link Hampton downtown to NH Seacoast Greenway (multi-use trail).	Hampton Master Plan (2023)	X	X	X	$$	Planning & Assessment; Public Access	Towns		
Goal 4	4.1	4.1-1	Maintain and regularly update the SHEA website with ongoing activities.		X	X	X	N/A	Education and Outreach	SHEA		
Goal 4	4.1	4.1-2	Continue and enhance public outreach efforts to engage and inform community members of flood hazards, vulnerability, and opportunities to increase resiliency and to solicit input from residents.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019)	X			N/A	Education and Outreach	Towns	SHEA	
Goal 4	4.1	4.1-3	Provide information to property owners about living shorelines and the importance of retaining the functions of natural shorelines, and implementing landscaping best practices.	Tides to Storms Vulnerability Assessment (RPC, 2015)	X			$	Education and Outreach	Towns		
Goal 4	4.1	4.1-4	Engage with residents living along or adjacent to the salt marsh to see the salt marsh as an ecosystem service for storm surge protection.	HSE Commons	X			$	Education and Outreach	SHEA	Towns	
Goal 4	4.2	4.2-1	Engage with the Coastal Research Volunteers program through the UNH Sea Grant program to increase citizen science partnering with HSE research projects.		X			$	Monitoring; Partner Collaboration	SHEA	UNH Sea Grant, Citizen Scientists	
Goal 4	4.3	4.3-1	Implement FEMA's High Water Mark Initiative. Communities implement the High Water Mark Initiative by providing information on past floods, such as documenting high water marks in public places, and posting maps and photographs of past floods on their websites. High water marks can be displayed on public buildings or on permanently installed markers. A High Water Mark is already installed at the Hampton Transfer Station. See Seacoast Remembrance Project in Durham, NH and Dover Rising Waters in Dover, NH for examples.	Tides to Storms Vulnerability Assessment (RPC, 2015)	X			$	Education and Outreach	Towns	SHEA	
Goal 4	4.3	4.3-2	Implement restoration projects (such as living shoreline) on town lands to demonstrate best practices, and the benefits and effectiveness of different restoration approaches. Offer tours of the demonstration projects. For example, Bicentennial Park in Hampton could be a good candidate for a demonstration site.	Tides to Storms Vulnerability Assessment (RPC, 2015); Hampton Master Plan (2023)	X	X		$$	Restoration; Education and Outreach	Towns		
Goal 4	4.3	4.3-3	Distribute information on coastal resiliency and other important estuary protection activities or needs through a variety of formats including mailed or posted pamphlets, newsletters or postings online (social media, town websites) or workshops or meetings.		X			$	Education and Outreach	Towns	SHEA	X

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	**OBJ #**	**ACTION -##**	**ACTION**	**SOURCE**	**By 2024**	**By 2027**	**By 2032**	**EST. COST**	**PROJECT TYPE**	**PROJECT LEAD**	**PARTNERS**	**Priority**
Goal 4	4.3	4.3-4	Organize and publicize regular environmental clean-up events to increase awareness of environmental issues related to the HSE.		X	X	X	$	Education and Outreach; Restoration	Towns	SHEA	X
Goal 4	4.4	4.4-1	Develop a public outreach and awareness program aimed at residents to promote stewardship on private property.		X			$	Education and Outreach	Towns	SHEA	
Goal 4	4.4	4.4-2	Publicize success stories of coastal resiliency projects to inspire other property owners to do the same. Examples can be from elevated homes, floodproofed buildings, property buyouts, etc. Property owners can receive technical assistance for coastal resiliency projects through the NH Coastal Landowner Technical Assistance Program (LTAP).		X			N/A	Education and Outreach	Towns	SHEA, DES, UNH Cooperative Extension, NHCAW	
Goal 5	5.1	5.1-1	Adopt the HSE Watershed Management Plan into each town's Comprehensive Master Plan.		X			N/A	Planning & Assessment	Towns; Village Precinct		X
Goal 5	5.1	5.1-2	Require that the Hampton Comprehensive Master Plan and future updates of the Comprehensive Master Plan integrate sea level rise (SLR) impacts and identify strategies for effectively responding to SLR and encouraging development in safe areas. Strengthen discussion of the estuary's role in mitigating flooding and storm surge; assess and map surrounding land use and buffers; provide specific land use recommendations for the Zoning Ordinance, Site Plan Regulations, and Subdivision Regulations; incorporate the estuary into the vision. Largely completed with Hampton Master Plan 2023 update.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Land Use Planning Audit (EF Design & Planning, LLC, 2020)	X			N/A	Planning & Assessment	Town of Hampton		
Goal 5	5.1	5.1-3	Update the Hampton Falls Comprehensive Master Plan to include a discussion of the coastal water resources in the water resources management and protection plan chapter; address climate change and hazards; incorporate maps and images.	Land Use Planning Audit (EF Design & Planning, LLC, 2020)		X		N/A	Planning & Assessment	Town of Hampton Falls		
Goal 5	5.1	5.1-4	Update the Seabrook Comprehensive Master Plan to enhance discussion of ecosystem services; identify opportunities to educate the public about estuary health and how land use management impacts the estuary; identify additional research and data needs.	Land Use Planning Audit (EF Design & Planning, LLC, 2020)		X		N/A	Planning & Assessment	Town of Seabrook		
Goal 5	5.1	5.1-5	Ensure that each of the watershed towns have Coastal Resiliency Plans and Open Space Plans in place and that future development conforms to those plans.	Hampton Master Plan (2023)		X		$$$	Planning & Assessment	Towns; Village Precinct		
Goal 5	5.1	5.1-6	Develop a Comprehensive Managed Retreat Plan to facilitate a thoughtful and equitable retreat approach over the coming decades.	Hampton Master Plan (2023)		X		$	Planning & Assessment	Towns; Village Precinct		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.1	5.1-7	Follow recommendations in the Hampton Coastal Resilience Report (2021) to 1) focus development and investment in low-risk areas; 2) protect resilient hubs and connectors; 3) live with the water; 4) address drainage systems; 5) facilitate relocation; 6) strengthen administrative capabilities; 7) support local business resiliency; 8) preserve and enhance coastal habitats; 9) build social capital; 10) elevate awareness; and 11) leverage regional and state capacities.	Hampton Coastal Resilience Report (SLR, 2021); Hampton Master Plan (2023)	X	X	X	$$$	Planning & Assessment; Conservation; Structural BMPs; Education and Outreach; Ordinances, Policies, & Regulations; Restoration	Town of Hampton		X
Goal 5	5.1	5.1-8	Complete an audit of existing ordinances and regulations and compare to the Master Plan to identify needs and gaps.	Hampton Master Plan (2023)	X			$	Planning & Assessment	Town of Hampton		
Goal 5	5.1	5.1-9	Continue to identify vulnerable assets and infrastructure for implementation plans that better adapt to changing conditions (e.g., nature-based solutions).		X	X	X	$$	Planning & Assessment	Towns; Village Precinct		
Goal 5	5.1	5.1-10	Initiate a discussion on how coastal properties are assessed and the impacts of sea level rise on properties.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019)	X			N/A	Planning & Assessment	Towns; Village Precinct		
Goal 5	5.1	5.1-11	Investigate opportunities to improve applicant, local board awareness of flood vulnerability by restructuring the project review process. Consider the merits of requiring Project Review Committee meeting before ZBA hearing.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)	X			$	Planning & Assessment; Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-12	Create Capital Reserve account or Community Resilience Incentive Zone (NH RSA 79-E) with seed funding to be used for grant match and cost share for municipal repairs, upgrades, flood mitigation, and/or projects identified in the Hazard Mitigation Plan, flood engineering studies, and other local or regional flood studies. Consider also a Stormwater Utility Fee to fund stormwater and coastal resilience projects.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)	X			$	Planning & Assessment; Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-13	Amend Town of Hampton Code Section 805-9(M)(1) to lower the threshold for authorized parking in municipal parking lots when tides are in excess of 9.7 feet (as opposed to 10.0 feet).	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)	X			N/A	Ordinances, Policies, & Regulations	Town of Hampton		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.1	5.1-14	Continue to work with out-of-compliance property owners to comply with the National Flood Insurance Program (NFIP) so that the Town can join the Community Rating System (CRS), the Community Resilience & Floodplain Administrator can track and identify points for CRS, and property owners who pay flood insurance can benefit from reduced premiums.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)	X			N/A	Planning & Assessment	Towns; Village Precinct		
Goal 5	5.1	5.1-15	Create a full time, permanent Community Resilience & Floodplain Administrator staff position. A percentage of this individual's role would be allocated to administering the floodplain ordinance and a percentage would be allocated to building climate resiliency and educating about flood and climate resiliency. May be an opportunity for a regional staff person. A temporary version of this position has been created in Hampton.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)		X		$	Enforcement	Towns; Village Precinct		
Goal 5	5.1	5.1-16	Establish an Implementation Committee to ensure that the various recommendations of the Comprehensive Master Plan are carefully considered and adopted in a timely manner, as appropriate.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)		X		N/A	Enforcement	Towns; Village Precinct		
Goal 5	5.1	5.1-17	Conduct a visioning effort to begin to identify potential positive, alternative land uses and activities for areas that are anticipated to be impacted by sea level rise.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)		X		$	Planning & Assessment	Towns; Village Precinct		
Goal 5	5.1	5.1-18	Review Zoning Ordinance, Site Plan Review Regulations, and Subdivision Regulations and identify opportunities and strategies to encourage and incentivize development in areas that are not vulnerable to current or potential future flooding.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)		X		$	Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-19	Form a subcommittee to work on development of a new coastal hazard overlay district that has higher regulatory standards for areas of the community at risk to flooding and sea level rise. One requirement within the overlay would be that individuals who submit an application to the Planning Board, or the building inspector if no Planning Board approval is required, utilize the NH Coastal Flood Risk Guidance. Another potential component could be inclusion of areas of predicted marsh migration under specific scenarios and timeframes.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)		X		$	Ordinances, Policies, & Regulations	Towns; Village Precinct		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.1	5.1-20	Establish a marsh migration overlay zone to prohibit new development in areas of predicted marsh migration under specific scenarios and timeframes.	Hampton Master Plan (2023)		X		$	Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-21	Develop a process or policy for staff and departments to follow to identify and account for climate change impacts when submitting a project for inclusion in the Capital Improvement Plan.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Hampton Master Plan (2023)		X		$	Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-22	Conduct an evaluation of freshwater wetlands to identify potential mitigation opportunities that will enhance water quality and habitat and other wetland functions. Pre-identified sites can be used to fulfill the requirement for compensatory mitigation as part of wetland permits.			X		$$	Planning & Assessment	Towns; Village Precinct		
Goal 5	5.1	5.1-23	Improve designs for dams, culverts, and bridges to maintain existing function and reconnect fragmented surface waters and protect high quality habitat for aquatic organisms.	Seabrook Master Plan (2011); Hampton Master Plan (2023)		X		$$	Planning & Assessment	Towns; Village Precinct		X
Goal 5	5.1	5.1-24	Implement the top four priority actions identified by PREP for the Town of Hampton: increase buffers on 1st-4th order streams to 100 ft; increase septic system and structure setbacks to 100 ft on surface waters; adopt fertilizer application setbacks for all waterbodies; use the NH Coastal Flood Risk Summary Part 2: Guidance for Using Scientific Projections to require project siting and design based on future climate projections (sea level rise, storm surge, groundwater rise, and precipitation).	PREPA (PREP, 2020); Hampton Master Plan (2023)	X			N/A	Ordinances, Policies, & Regulations	Town of Hampton		
Goal 5	5.1	5.1-25	Implement the top four priority actions identified by PREP for the Town of Hampton Falls: adopt 100 ft buffers on all waterbodies, including wetlands; increase septic system setbacks to 100 ft for all waterbodies; increase primary structure setbacks to 100 ft for freshwater wetlands; adopt a Coastal Hazards Master Plan Chapter.	PREPA (PREP, 2020)		X		N/A	Ordinances, Policies, & Regulations	Town of Hampton Falls		
Goal 5	5.1	5.1-26	Implement the top four priority actions identified by PREP for the Town of Seabrook: increase buffers to 100 ft for all waterbodies; increase structure setbacks to 100 ft for all waterbodies; use the NH Coastal Flood Risk Summary Part 2: Guidance for Using Scientific Projections to require project siting and design based on future climate projections (sea level rise, storm surge, groundwater rise, and precipitation); adopt model stormwater management regulations.	PREPA (PREP, 2020)		X		N/A	Ordinances, Policies, & Regulations	Town of Seabrook		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	**OBJ #**	**ACTION -##**	**ACTION**	**SOURCE**	**By 2024**	**By 2027**	**By 2032**	**EST. COST**	**PROJECT TYPE**	**PROJECT LEAD**	**PARTNERS**	**Priority**
Goal 5	5.1	5.1-27	Adopt the regulatory and non-regulatory climate adaptation actions recommended by the RPC (2015) and/or in each town's Natural Hazards Mitigation Plan. Overlaps with the Hampton-specific recommendations from the 2019 CHAT Review (SHEA, 2019).	Tides to Storms Vulnerability Assessment (RPC, 2015)	X	X		N/A	Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-28	Regulate development in Conservation Focus Areas following recommendations in The Land Conservation Plan for New Hampshire's Coastal Watersheds: establish a conservation overlay district, require conservation subdivisions, implement a high standard of development clustering and open space, reduce overall development density, increase riparian and wetland buffers, use minimum impact site design and construction standards, implement use restrictions and performance standards.	The Land Conservation Plan for New Hampshire's Coastal Watersheds (Zankel et al., 2006); New Hampshire's Coastal Watershed Conservation Plan (Steckler & Ormiston, 2021)	X	X		N/A	Ordinances, Policies, & Regulations	Towns; Village Precinct		
Goal 5	5.1	5.1-29	Adopt Floodplain Management Ordinance Amendments (Zoning Ordinance Section 2.4). Adopt Wetland Cons.District Amendments (Zoning Ordinance Section 2.3). See source for specifics.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019)		X		N/A	Ordinances, Policies, & Regulations	Town of Hampton		
Goal 5	5.1	5.1-30	Establish a shoreland protection district and ordinance along major watercourses such as Taylor River, Hampton Falls River, Brown's River, and along other smaller brooks. The ordinance can address setbacks for buildings and septic systems, cutting restrictions for timber removal, minimal shoreland frontage requirements, and prohibition of certain high-risk land uses. Update erosion and sedimentation control regulations. Consider a maximum coverage percentage for commercial and industrial lots. Require an environmental impact study for large subdivisions. Amend subdivision and site plan review regulations to promote the use of catch basins designed to trap oil and sediments; encourage road designs which require less use of de-icing chemicals; and require that additional runoff created by a development be retained on-site for groundwater recharge and water quality protection.	Hampton Falls Master Plan (2019)		X		N/A	Ordinances, Policies, & Regulations	Town of Hampton Falls, Other Towns (as applicable); Village Precinct		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.1	5.1-31	Adopt recommendations from study on adaptation strategies for coastal flooding; protect key municipal infrastructure; and establish a floodplain overlay district to minimize storm and flood damage to existing developed properties in the dune and estuarine area. Adopt land development regulations aimed at minimizing impervious surfaces and stormwater flooding, and reducing or preventing nonpoint source pollution. Encourage adoption or buffers and setbacks that restore and maintain ecosystem services.	Seabrook Master Plan (2011)		X		N/A	Ordinances, Policies, & Regulations	Town of Seabrook, Other Towns (as applicable); Village Precinct		
Goal 5	5.1	5.1-32	Begin discussions with elected officials, planning board and zoning board of adjustment about long term land use development standards, building code, and zoning options in areas at high risk for flooding and erosion.	Seabrook Master Plan (2011)	X			N/A	Ordinances, Policies, & Regulations	Town of Seabrook, Other Towns (as applicable); Village Precinct		
Goal 5	5.1	5.1-33	Contact the DPW to gather information on current MS4 compliance activities and how those activities align with the EMP's goals and management strategies.		X			N/A	Planning & Assessment	SHEA	Town DPWs	
Goal 5	5.2	5.2-1	Prioritize land conservation initiatives in areas of predicted marsh migration (using SLAMM results of salt marsh extent under different sea level rise scenarios). Initiatives include identifying and purchasing high risk land for preservation or restoration of natural conditions in support of retreat. Potential conservation land was already identified by SHEA for the three watershed towns. Compare and update SHEA's work to the NH Plan for Resilient Salt Marshes.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); Tides to Storms Vulnerability Assessment (RPC, 2015); HSE Conservation Land Project (2020, online presentations); Hampton Master Plan (2023)	X	X	X	$$$	Planning & Assessment; Conservation	Towns	SHEA, Rockingham Land Trust/SELT, TNC	X
Goal 5	5.2	5.2-2	Increase funding and resources for land conservation, land management programs, and land stewardship activities. Identify potential conservation buyers and property owners interested in easements within the watershed. Use available funding mechanisms, such as the Regional Conservation Partnership Program (RCPP) and the Land and Community Heritage Investment Program (LCHIP), to provide conservation assistance to landowners.	Tides to Storms Vulnerability Assessment (RPC, 2015)	X	X	X	$$$	Planning & Assessment; Conservation	Towns	SHEA, Rockingham Land Trust/SELT, TNC	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.2	5.2-3	Maintain or commence stewardship of fee-owned conservation lands, including documenting and mapping the property's natural resource values and features, determining management goals through a management plan, secure funding or other resources for stewards, and institute a long-term monitoring program.	The Land Conservation Plan for New Hampshire's Coastal Watersheds (Zankel et al., 2006); New Hampshire's Coastal Watershed Conservation Plan (Steckler & Ormiston, 2021); Hampton Master Plan (2023)	X	X	X	$$	Land Management; Planning & Assessment; Monitoring	Towns	Rockingham Land Trust/SELT, TNC	
Goal 5	5.2	5.2-4	Adopt The Land Conservation Plan for New Hampshire's Coastal Watersheds in each of the three towns' Comprehensive Master Plans. Use it to establish a consistent framework for land conservation in the coastal watersheds area. Protect land through acquisition of conservation easements or fee simple ownership, especially the Core Areas identified within the Conservation Focus Areas. Regulate the location, density, and design of development within Conservation Focus Areas to minimize harmful impacts while allowing for a reasonable level of development. See Objective 5.1.	The Land Conservation Plan for New Hampshire's Coastal Watersheds (Zankel et al., 2006); New Hampshire's Coastal Watershed Conservation Plan (Steckler & Ormiston, 2021)	X	X		N/A	Planning & Assessment; Conservation	Towns		X
Goal 5	5.2	5.2-5	Consider adopting innovative land use controls, both in the zoning ordinance and subdivision and site plan regulations, to promote open space preservation. Consider implementation of a transfer of development rights (TDR) program to further encourage voluntary open space preservation. See Objective 5.1.	Hampton Master Plan (2023); Seabrook Master Plan (2011)	X	X		N/A	Ordinances, Policies, & Regulations	Towns		
Goal 5	5.3	5.3-1	Evaluate the impacts of saltwater intrusion into aquifers (e.g., located underneath Collins Street and South Main Street near the marsh).	Seabrook Adaptation Strategies (RPC, 2009)		X		$$	Planning & Assessment	Towns		
Goal 5	5.3	5.3-2	See Objectives 1.1 and 5.1.									
Goal 5	5.4	5.4-1	Use dredge material to replenish beaches and dunes if deemed environmentally sound. Use beach profiling dataset to inform where dredge materials may be most beneficial.	Tides to Storms Vulnerability Assessment (RPC, 2015)	X	X	X	Ongoing	Dune Management; Restoration; Planning & Assessment	Towns		X
Goal 5	5.4	5.4-2	Identify a list of "elevation challenged" salt marsh units for possible sediment placement from Harbor dredging.	HSE Collaborative (various presentations, meeting minutes)	X			$	Planning & Assessment	UNH	SHEA, Towns	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	**OBJ #**	**ACTION -##**	**ACTION**	**SOURCE**	**By 2024**	**By 2027**	**By 2032**	**EST. COST**	**PROJECT TYPE**	**PROJECT LEAD**	**PARTNERS**	**Priority**
Goal 5	5.4	5.4-3	Coordinate with USACE and NH Dredge Management Task Force to understand administrative considerations of beneficial use of dredged sediments.	HSE Collaborative (various presentations, meeting minutes)	X			N/A	Planning & Assessment	Towns	SHEA, USACE, NH Dredge Management Task Force	
Goal 5	5.4	5.4-4	Continue to complete dredging projects from November to June of each year to avoid shorebird disturbance during critical breeding times.	Ph I HSE Conservation Project (McKinley and Hunt, 2008)	X	X	X	N/A	Planning & Assessment	Towns	Towns	
Goal 5	5.5	5.5-1	Continue partnering with and supporting SHEA. Continue SHEA's and the towns' partnership with NH Coastal Adaptation Workgroup in climate adaptation activities that facilitate, coordinate, provide technical information, and convene public outreach events for the estuary towns.	Tides to Storms Vulnerability Assessment (RPC, 2015); Hampton Master Plan (2023)	X	X	X	N/A	Partner Collaboration	Towns	SHEA, NHCAW	
Goal 5	5.5	5.5-2	Continue and expand the work of the Hampton Coastal Hazards Adaptation Team (CHAT) to better understand and prepare for flood risks in the watershed communities. Establish a similar group, the Coastal Resilience Team, in Seabrook and Hampton Falls.	Hampton Master Plan (2023)	X	X	X	N/A	Partner Collaboration; Planning & Assessment	Towns	SHEA, DES, Hampton Residents	
Goal 5	5.5	5.5-3	Establish a Master Plan Implementation Committee with SHEA representation to oversee the implementation of Hampton's updated 2023 Master Plan. Collaboration with SHEA will ensure that pertinent action items in both plans are addressed consistently and simultaneously.	Hampton Master Plan (2023)	X	X	X	N/A	Partner Collaboration; Planning & Assessment	Town of Hampton	SHEA	
Goal 5	5.5	5.5-4	Explore the feasibility of a more formal structure for the HSE Collaborative, with articulated goals and objectives and organized teams. Continue to hold webinars or meetings that build on these conversations or start new ones on different projects: 2 or 4 times a year were the most popular survey choices. Be more targeted with agendas, i.e., talk about proposal ideas for specific funding opportunities and/or invite organizations to share projects or ideas they need help building out, etc. Reference the “big idea” list from the December 2020 survey to help identify individuals to help frame and participate in discussions.	Prospectus (Jalbert Leonard et al., 2021)	X			N/A	Partner Collaboration	SHEA	PREP, DES, USFWS	
Goal 5	5.5	5.5-5	Establish interstate collaboration with Massachusetts watershed towns for future planning and protection efforts.		X			N/A	Partner Collaboration	SHEA		
Goal 5	5.5	5.5-6	Work with state and federal partners to match management/research needs with relevant funding opportunities and develop a list of potential projects to help organize future conversations.	Prospectus (Jalbert Leonard et al., 2021)	X			$	Partner Collaboration; Planning & Assessment	SHEA	DES, PREP, USFS, Audubon, Towns, UNH	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.5	5.5-7	Use other planned meetings and events to continue the conversations. For example, USFWS holds an ongoing salt marsh webinar series. Build a sense of shared ownership by engaging new individuals and different organizations in leading future conversations.	Prospectus (Jalbert Leonard et al., 2021)	X			N/A	Partner Collaboration	SHEA		X
Goal 5	5.5	5.5-8	Complete an organizational conceptual diagram of key stakeholders, researchers, etc. with the types of data they collect and how/if they communicate amongst each other. Use this to identify and improve on key gaps in coordination/communication.		X			$	Planning & Assessment; Partner Collaboration; Education and Outreach	SHEA		
Goal 5	5.5	5.5-9	Continue to work with students at Seabrook Middle School on a long-term water quality monitoring project currently in the Cains Brook-Mill Creek watershed but potentially in other areas of the HSE watershed.	HSE Commons	X			$	Monitoring; Education and Outreach	UNH		
Goal 5	5.5	5.5-10	Establish an online database for partners to access and share data, reports, or other information related to HSE.			X		$$	Education and Outreach; Partner Collaboration	SHEA	PREP	
Goal 5	5.6	5.6-1	Seek funding to continue engineering and hydrogeological studies that will help to address flooding and drainage in vulnerable areas. Gather baseline data to improve analysis of coastal and riverine flood risks resulting from a combination of storm surge, sea-level rise, and extreme precipitation events in coastal areas directly exposed to the Atlantic Ocean and inland areas with tidal rivers, bays, and marshes. Utilize data obtained through flood engineering studies as baseline data for future modeling efforts and studies.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019); NH Coastal Risk and Hazards Commission (2016)		X		$$	Planning & Assessment	Towns		
Goal 5	5.6	5.6-2	a) Coordinate a water level gaging network for the HSE area. Get the Hampton Harbor NERACOOS gage formally recognized by NOAA with a formal datum, including any significant deviation from background datums, as well as good connections to NAVD88. Deploy telemetry based sensors throughout the estuary; formalize the process for observations of flood elevations; and conduct regular gaging of major tributaries. b) Connect water level gaging to other sea level rise monitoring work in the area, including Sediment Elevation Tables (SETs) and shallow groundwater measurements. Evaluate six existing SETs on a bi-annual cycle. Assess changes in shallow groundwater flooding depth and duration.	HSE Commons; HSE Collaborative (various presentations, meeting minutes)		X		$$	Monitoring	Towns	SHEA, PREP, UNH, NOAA	X

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	**OBJ #**	**ACTION -##**	**ACTION**	**SOURCE**	**By 2024**	**By 2027**	**By 2032**	**EST. COST**	**PROJECT TYPE**	**PROJECT LEAD**	**PARTNERS**	**Priority**
Goal 5	5.6	5.6-3	Advance the conversation on meeting water level data needs by 1) convening a targeted discussion on how best to analyze gage data and use it to calculate tidal datum, maintain the gage, communicate gage results, deploy more sensors, and use in hydrodynamic modeling; and 2) engaging USFWS (Susan Adamowicz) to share efforts by the Massachusetts Salt Marsh Workgroup Hydrology subcommittee to characterize water level data needs.	Prospectus (Jalbert Leonard et al., 2021)	X			$	Monitoring; Partner Collaboration	Towns	SHEA, PREP, UNH, NOAA	
Goal 5	5.6	5.6-4	Perform hydrodynamic modeling of the estuary to understand variable water levels across the marsh plain. HSE may be used as a pilot study area for the IOOS Coastal and Ocean Modeling Testbed (COMT) grant program project to improve model coupling techniques.	HSE Collaborative (various presentations, meeting minutes)	X			In Progress	Modeling	UNH		
Goal 5	5.6	5.6-5	Conduct additional applied research to better understand the capacity of natural resources like salt marshes and eelgrass beds to respond to projected changes in storm surge, sea level, and extreme precipitation.	Preparing NH (NH Coastal Risk and Hazards Commission, 2016)			X	$$	Research	UNH		
Goal 5	5.6	5.6-6	Analyze High Resolution Tidal Wetland Maps and metrics from the NH Salt Marsh Plan for statistics and observations.	HSE Collaborative (various presentations, meeting minutes)	X			$	Planning & Assessment	UNH	PREP, SHEA, Towns	
Goal 5	5.6	5.6-7	Conduct natural resource surveys to understand the status of biogenic land forms (salt marsh and dune).		X			$$	Planning & Assessment	Towns	SHEA, UNH	
Goal 5	5.6	5.6-8	Initiate long-term vegetation monitoring at multiple scales including transects/quadrats and remote sensing. Transects should capture transitional zones from creek edge to upland edge and monitor for at least three consecutive seasons. Remote sensing includes high resolution aerial image capture and field validation for completing a change analysis from older aerials.	HSE Collaborative (various presentations, meeting minutes)	X	X	X	$$	Monitoring	UNH		X
Goal 5	5.6	5.6-9	Consider potential methods for enhanced assessment of salt marsh vegetation. 1) Organize a field trip or meeting to compare transect designs in Webhannet and Great Bay to assess their utility for monitoring sea level rise impacts. 2) Advance citizen science picture post project to field verify SLAMM models. 3) Explore the RISMA protocol implemented at the Narragansett Bay NERRS.	Prospectus (Jalbert Leonard et al., 2021)	X			$	Partner Collaboration; Monitoring	SHEA	UNH	
Goal 5	5.6	5.6-10	Update rare plant and exemplary community surveys.	HSE Collaborative (various presentations, meeting minutes); HSE Commons	X			$	Planning & Assessment	SHEA	UNH, Towns	

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.6	5.6-11	Develop a sediment budget for the estuary and use the sediment budget to support restoration by 1) convening a targeted discussion about the expansion of Surface Elevation Table (SET) replicates; 2) planning a field trip to assess the effectiveness of Thin-Layer Placement (TLP) sites for marsh stabilization prior to sediment addition; 3) engaging UNH (Dave Burdick, Diane Foster) to share project results exploring washover from dunes to marshes.	Prospectus (Jalbert Leonard et al., 2021); HSE Collaborative (various presentations, meeting minutes)	X	X		$$	Research; Monitoring; Partner Collaboration	SHEA	UNH	X
Goal 5	5.6	5.6-12	Understand sediment dynamics such as how coarse grained sediment from inlets become incorporated in salt marsh sediments and how salt marsh accretion is impacted by ditch remediation.	HSE Commons		X	X	$$	Research	UNH		
Goal 5	5.6	5.6-13	Quantify the amount and variability of the flux of nitrogen, carbon, and sediments from the watershed to the estuary (storm event, seasonal, interannual) and how conditions in the estuary respond.	HSE Commons		X	X	$$	Research	UNH		
Goal 5	5.6	5.6-14	Obtain high resolution bathymetry and elevation data. New release of LiDAR pending.	HSE Commons	X			In Progress	Planning & Assessment	UNH	SHEA, Towns	
Goal 5	5.6	5.6-15	Understand how dredging and sediment management changes water levels.	HSE Commons			X	$$	Research	UNH		
Goal 5	5.6	5.6-16	Understand groundwater rise impact on water quality as it relates to wastewater and stormwater from vulnerable infrastructure.	HSE Commons			X	$$	Research; Planning & Assessment	UNH	Towns, SHEA	
Goal 5	5.6	5.6-17	Investigate the effects of tidal crossings on salt marsh health, processes, and functions and values; monitor tidal crossing replacement projects to determine efficacy.	Resilient Tidal Crossings (NHDES, 2019)			X	$$	Research; Monitoring	UNH	Towns, SHEA, DOT, DES	X
Goal 5	5.6	5.6-18	Conduct an assessment to better understand and plan for the economic impacts (development, tourism, tax base, etc.) associated with sea level rise.	2019 CHAT Review (SHEA & NHDES Coastal Program, 2019)		X		$	Planning & Assessment	Towns		X
Goal 5	5.6	5.6-19	Consider a new dye study of the Hampton Municipal Wastewater Facility, utilizing a long-term injection that begins on the start of an ebbing tide and continues into the next flooding. The study should aim to delineate the 1000:1 dilution area under current operational conditions at the Hampton WWTF.	Sanitary Survey Report for Hampton/Seabrook Harbor, NH (Nash & Dejadon, 2019)		X		$	Monitoring	DES		
Goal 5	5.6	5.6-20	Continue sampling of the Seabrook and Hampton municipal wastewater effluent (raw influent, predisinfection effluent, and final effluent) under varying operational conditions to quantify variability in male specific coliphage concentration and removal efficiency.	Sanitary Survey Report for Hampton/Seabrook Harbor, NH (Nash & Dejadon, 2019)	X	X	X	$	Monitoring	DES		

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.6	5.6-21	Continue with flushing/purging (contaminant reduction) studies in Hampton Harbor, including documentation of pre-storm bacteria levels in seawater and shellfish tissue.	Sanitary Survey Report for Hampton/Seabrook Harbor, NH (Nash & Dejadon, 2019)	X	X	X	$	Monitoring	DES		
Goal 5	5.6	5.6-22	Continue with an expanded characterization of summer and autumn fecal coliform concentrations in seawater and shellfish tissue.	Sanitary Survey Report for Hampton/Seabrook Harbor, NH (Nash & Dejadon, 2019)	X	X	X	$	Monitoring	DES		
Goal 5	5.6	5.6-23	Conduct research to fulfill avian data needs: 1) identify sparrow location/breeding areas at a selection of marshes; 2) identify and assess the condition of a selection of marshes; 3) complete a RAPID demo to better identify productive marshes; 4) increase the number of stations to assess elevation; 5) prioritize marshes for intervention and identify fringe marsh as refuge; 6) conduct a survey of common terns and roosting information for shorebirds; and 7) assess nekton (transient/resident), impact of burrowing crabs, and info on other key habitats like shellfish beds that may have a relationship with marsh habitat.	Prospectus (Jalbert Leonard et al., 2021)	X		X	$$	Research; Monitoring	UNH	Audubon, DES, SHEA	
Goal 5	5.6	5.6-24	Understand site conditions that maximize reproductive success for shorebirds by completing a more detailed study of invertebrate populations with respect to shorebird foraging patterns, the role of freshwater inputs to pools used by shorebirds along the estuary's northern edge, nest site selection by salt marsh sparrows, and productivity measurements of the area's breeding Willet and Common Tern populations. Surveys were conducted from 2018-2020 to identify important roosting and feeding sites and compared to those sites identified in the 2006-2007 study.	Ph I HSE Conservation Project (McKinley and Hunt, 2008); Hunt (2020)		X		$$	Research; Monitoring	Audubon, UNH	NHFG, DES, SHEA	
Goal 5	5.6	5.6-25	Locate and compile secondary data on fish and wildlife species in the marsh collected by Audubon, UNH, state fish and wildlife agencies, etc.	HSE Commons	X			$	Planning & Assessment	SHEA	UNH, Audubon, DES, NHFG	
Goal 5	5.6	5.6-26	Conduct studies on population dynamics and toxicity in oysters and softshell clams; characteristics of key habitats such as shellfish beds that may have relationship with the marsh habitat; and impact of toxic contaminants on clam flats.	HSE Commons		X		$$$	Research	DES	UNH	
Goal 5	5.6	5.6-27	Determine the impact of salt marsh disappearance due to sea level rise on species that use salt marshes.	HSE Commons			X	$$	Research	UNH	NHFG, Audubon	
Goal 5	5.6	5.6-28	Complete spatially intensive assessment of nutrients, sediment, seagrasses, fish, and oysters to determine whether they co-vary in health across the estuary.	HSE Commons			X	$$$	Research	UNH		X

MANAGEMENT STRATEGIES					TIMELINE			IMPLEMENTATION				
GOAL #	OBJ #	ACTION -##	ACTION	SOURCE	By 2024	By 2027	By 2032	EST. COST	PROJECT TYPE	PROJECT LEAD	PARTNERS	Priority
Goal 5	5.7	5.7-1	Maintain and enhance emergency access and evacuation routes, with mass transportation options available for those who cannot rely on personal vehicles. Ensure social services such as food and shelter assistance are prepared to operate following emergency events. Provide resources and education to vulnerable populations in need of protection services for themselves and/or their homes in response to extreme weather or tidal events.	Tides to Storms Vulnerability Assessment (RPC, 2015); Hampton Coastal Resilience Report (SLR, 2021); Hampton Master Plan (2023)	X			$$	Planning & Assessment; Education and Outreach; Emergency Preparedness; Equity	Towns		X
Goal 5	5.7	5.7-2	Expand upon the existing high tide alert system and fund, install, and maintain an improved high tide alert system to inform residents (through text message, automated phone calls, emails, mobile-app alerts, or sirens) of pending tide levels that may require them to prepare by moving vehicles, securing outdoor equipment, and changing plans.	Hampton Master Plan (2023)		X		$	Emergency Preparedness; Equity	Towns		
Goal 5	5.7	5.7-3	Reapply to the NWS "StormReady" program to increase town's preparedness for and public awareness of severe weather events.	Hampton Master Plan (2023)		X		$	Emergency Preparedness; Equity	Towns		
Goal 5	5.7	5.7-4	Provide affordable housing that is hazard resilient and safe for vulnerable populations.				X	$$$	Planning & Assessment; Hazard Mitigation & Climate Resiliency; Equity	Towns		X
Goal 5	5.7	5.7-5	Engage with and educate community-based organizations and youth groups such as schools, clubs, etc. Develop liaison programs for community-based organizations to participate in hazard mitigation and climate resilience planning.	Hampton Coastal Resilience Report (SLR, 2021)		X		$	Partner Collaboration; Education and Outreach; Hazard Mitigation & Climate Resiliency; Equity	Towns		X
Goal 5	5.7	5.7-6	Provide hazard zone disclosure information to new homebuyers and renters.	Hampton Coastal Resilience Report (SLR,2021); Hampton Master Plan (2023)	X			$	Education and Outreach; Hazard Mitigation & Climate Resiliency; Equity	Towns		X