Peconic Estuary PROGRAM

September 2019

Peconic Estuary Program Climate Resiliency Assessment Services

Peconic Estuary Program Climate Vulnerability Assessment and Action Plan

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List of Acronyms and Abbreviations

CAC	Citizens' Advisory Committee
CCMP	Comprehensive Conservation Management Plan
CEHA	Coastal Erosion Hazard Area
CLPS	Critical Lands Protection Strategy
CNRA	Critical Natural Resource Area
CO2	carbon dioxide
CPF	Community Preservation Fund
CRA	climate ready assessment
CRRA	Community Risk and Resiliency Act
CWA	Clean Water Act
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HAB	harmful algal bloom
I/A OWTS	Innovative and Alternative Onsite Wastewater Treatment System
NEP	National Estuary Program
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYDOS	New York Department of State
NYSERDA	New York State Energy Research and Development Authority
PDR	purchase of development rights
PEP	Peconic Estuary Program
QAPP	Quality Assurance Project Plan
QC	quality control
SLAMM	Sea Level Affecting Marshes Model
SLR	sea level rise
TAC	Technical Advisory Committee
TDR	transfer of development rights
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
Workbook	Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans

SECTION 1:
INTRODUCTION

Authorized by Section 320 of the Clean Water Act (CWA), the U.S. Environmental Protection Agency's (USEPA's) nonregulatory National Estuary Program (NEP) works to protect and restore the water quality and ecological integrity of estuaries of national significance. In 1992, New York's Peconic Estuary became the 20th of 28 estuaries in the nation designated an "Estuary of National Significance" and the Peconic Estuary Program (PEP)—a collaborative partnership of local, state, and federal governments; citizens; environmental groups; businesses; industries; and academic institutions—was established. PEP and its 27 counterparts in the NEP develop and implement long-term Comprehensive Conservation Management Plans (CCMPs) based on local priorities. PEP's current CCMP was approved in 2001 and includes a Critical Lands Protection Strategy (CLPS) that guides land preservation in the watershed.

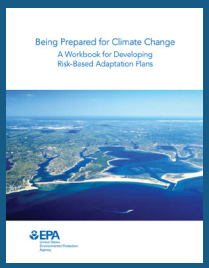
The Peconic Estuary faces numerous pressures including development, habitat loss, and nutrient loading. Climate change poses another set of challenges; among them are sea level rise (SLR), more frequent and more intense storms, and changing weather patterns. Suffolk County has already seen a 2.3°C (4.14°F) increase in annual temperature since the late 1890s, above the 1°C average increase for the United States over the same period (Mufson et al. 2019). All these pressures and challenges have the potential to further degrade water and habitat quality and lead to greater habitat loss and fragmentation. But PEP's 2001 CCMP and CLPS do not take climate change into account.

In 2016, PEP embarked on a Climate Ready Assessment (CRA) Project to incorporate climate change into an updated CLPS, to conduct a risk-based climate change vulnerability assessment, and to develop an adaptation action plan consistent with USEPA's Climate Ready Estuaries Program. The CRA included broad stakeholder outreach and collaboration to fully identify risks. It also included the development of tools to identify the spatial distribution of potential climate change impacts and to provide a way to prioritize land for protection based on revised environmental criteria that include climate change considerations.

This report documents the approach, methods, and results of the CRA, and it presents a climate-ready action plan based on the project's results. PEP is updating its CCMP separately and will incorporate work from the CRA in the revised CCMP, which is scheduled to be finalized in December 2019.

Climate change is a formidable threat, but an adaptation strategy that stimulates collective engagement and ingenuity has the potential to make the Peconic Estuary and its surrounding communities more resilient.

Because the science of predicting the future effects of climate change is dynamic and will be affected by how society perceives and responds to the threat of global warming, this report presents risks and vulnerabilities based on current scientific knowledge. Climate change will also affect most aspects of resource management and conservation. Therefore, PEP's efforts to address climate change will be a continuous process including periodic updates to the assessments described in this report and to the larger CCMP.



Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans

For more information on the USEPA Climate Workbook, visit:
https://www.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans

THE PECONIC ESTUARY

The Peconic Estuary lies between the North and South Forks of eastern Long Island in New York's Suffolk County (Figure 1). The Peconic watershed comprises the land that contributes groundwater and stormwater runoff to the Peconic River and the Peconic Bay, including areas in the towns of Brookhaven, East Hampton, Southampton, Riverhead, Southold, and Shelter Island and in the villages of Greenport, North Haven, and Sag Harbor. Because municipal or other sewage treatment is limited, most of the groundwater and stormwater water inputs come from non-point sources and individual residential cesspools and septic systems.

The natural environment of the Peconic watershed is composed of terrestrial uplands, a freshwater river system, and a brackish tidal bay. Among the terrestrial areas are protected undisturbed habitats—including areas of maritime red cedar and maritime oak forests, coastal oak-holly forests, pitch-pine oak, and the rare dwarf pitch-pine plain communities—as well as maritime grasslands and heathlands. The Peconic River is Long Island's longest; from its headwaters in Brookhaven, the river flows eastward almost entirely within the Central Pine Barrens, a protected swath of land, groundwater, and surface water, before emptying into Flanders Bay in Riverhead. The river's depth varies from mere inches to 8 feet. Adjacent habitats include freshwater wetlands, coastal plain ponds, vernal pools, bogs, fens, swamps, the rare coastal plain poor fen, and Atlantic white cedar swamp communities (PEP 2019). The Peconic Bay is a relatively shallow system made up of many bays and creeks, with deeper open water zones. Freshwater from the Peconic River and water from numerous brackish creeks result in lower salinity levels in the bay than in the adjacent Long Island Sound and Atlantic Ocean (PEP 2019).

Settled by Native Americans 10,000 to 13,000 years ago and by Europeans in the 1600s, the Peconic Estuary has a long agricultural and maritime history (Wick 2018). Predominant land uses in the watershed today are residential (suburban), recreational (tourism), and agricultural. The Peconic River and Peconic Bay are used extensively for recreational boating, swimming, and fishing. The Peconic Bay also supports commercial fisheries including bay scallop, weakfish, winter flounder, and a growing shellfish aquaculture program (PEP 2015). In addition to year round residents, the area has a sizeable second home market and tourist industry, with populations tripling during the summer high season, especially on the South Fork. The population has increased during the summer for generations, but lately the tourist season has been expanding into the fall and early winter with the growth of the wine industry and agritourism, including pumpkin picking and Christmas tree farms (Salamanca 2019). Large-scale commercial industry in the area is limited.

Figure 1: Peconic Estuary Watershed

Note: Orange line denotes the boundary of the watershed.

Comprehensive Conservation and Management Plan

More information on the CCMP, including the updated CCMP, when available can be found at: ***https://www.peconicestuary.org/protect-the-peconic/ccmp/***

COMPREHENSIVE CONSERVATION AND MANAGEMENT PLAN

PEP acts as a "boundary organization" by bringing diverse stakeholders together to address priority issues in the Peconic Estuary watershed through monitoring, research, collaboration, and education. PEP is managed according to the CCMP, which promotes a holistic approach to restoring, improving, maintaining, and protecting the Peconic Estuary, its watershed, and the waters of Peconic Bay. Priority management topics are brown tides, nutrient inputs, habitat and living resources, pathogens, toxic pollutants, and critical lands protection. These topics, plus the need for public education and outreach, form the bases for CCMP action plans. The CCMP also establishes a Management Conference consisting of the Policy Committee, Management Committee, Citizens Advisory Committee (CAC), Technical Advisory Committee (TAC), and Local Government Committee.

In 2018, through a series of public workshops and technical meetings, PEP began updating the CCMP to incorporate changes in priorities, including climate change, and background studies. The updated CCMP is scheduled to be finalized in December 2019.

Community Preservation Fund (CPF)

The CPF is a public program managed by the five East End Towns for the protection of farmland, open space, and community character. The CPF was established by voter referendum in 1998 and is a one-time real estate transfer tax of 2% on improved or vacant property.

In 2016, voters extended the CPF to 2050 and approved an amendment allowing towns to invest up to 20% of the funds in water quality improvement projects.

CRITICAL LANDS PROTECTION STRATEGY

Protecting land that is critical to the health of the Peconic Estuary from future development is a high priority for PEP, municipalities, and the public. One goal of the CCMP is to protect PEP designated Critical Natural Resource Areas (CNRAs) throughout the Peconic Estuary. Recognizing the need to be strategic and focused, PEP developed the CLPS in 2004 to help identify and prioritize undeveloped parcels of land with the greatest potential to protect and preserve the health of the Peconic Estuary. PEP used a variety of tools, including Geographic Information Systems (GIS), to evaluate parcels "through the lens" of habitat and water quality protection and to rank them by their preservation value. The original criteria PEP used to identify priority parcels are as follows:

- Their proximity to the shoreline
- Their location in a nitrogen-impaired subwatershed or in a CNRA
- The presence of wetlands (as defined by the National Wetlands Inventory)
- Their size relative to other protected lands
- The potential to aggregate multiple adjacent preserved parcels

The CLPS criteria have been used in the Peconic Estuary watershed by municipalities and other land stewards, such as the Peconic Land Trust, to help prioritize land purchases and other conservation strategies. Although funds for land preservation come from a variety of sources, the most significant is the Community Preservation Fund (CPF) which is administered by the five East End Towns (Shelter Island, Southold, Riverhead, Southampton, and East Hampton). This funding is supplemented by county and state governments and by not-for-profit organizations, especially The Nature Conservancy and the Peconic Land Trust (PEP 2015).

Climate change presents new challenges for the Peconic Estuary. To create a framework for targeted land protection, management, and restoration in the face of climate change, PEP has updated its CLPS criteria to incorporate the most current climate resilience and natural resource data.

Climate Change

For Up-to-Date Information in Climate Change in the Peconic Estuary
https://www.peconicestuary.org/threats-to-the-peconic/climate-change/

CLIMATE CHANGE IN THE PECONIC ESTUARY

Conservative projections for the Long Island region include air temperature increases from 3°F to 6.6°F by 2050, along with greater temperature variability, increased seasonality, and more frequent extreme temperature events (Horton et al. 2014). Ocean temperatures in the area are expected to rise between 4°F and 8°F over the next century. And although rainfall will likely increase in both quantity and intensity in the area—with an increase in total rainfall of 1% to13% by 2050—periods of drought are also expected to increase (Horton et al. 2014).

SLR presents one of the most immediate risks to the Peconic watershed. Rising waters threaten residential and commercial infrastructure and investments, transportation infrastructure, habitat, recreation access and facilities, and drinking water (due in large part to saltwater intrusion). Sea levels are already rising, and the region is seeing more "sunny day" flooding when high tides reach levels normally seen only as a result of coastal storms or king tides[1] (Figure 2). In the longer term, access to Orient Point and Montauk may become restricted as roadways are regularly inundated at high tide (Gobler et al. 2014). The PEP priorities on which climate change will have a direct impact—habitat, species diversity and populations, water quality, and groundwater—are discussed in the following sections.

Figure 2: Sunny Day Flooding in Peconic, New York

Photo taken July 2019

1) A king tide is an exceptionally high tide that typically occurs during a new or full moon and when the moon is at its perigee (i.e., closest point to the earth), or during specific seasons around the country.

Habitat

The Peconic watershed supports a variety of natural habitats and species, including dwarf pitch pine forests, salt marshes, eelgrass and soft bay-bottom communities. Some of these are unique to New York State and found in few places outside the Peconic Estuary. All are important to the ecology and productivity of the ecosystem (PEP 2015). More than 100 endangered or rare species are supported by the watershed's habitats (PEP 2019). The loss of wetlands and eelgrass (*Zostera marina*) are among the expected habitat changes.

Large areas of wetlands have been protected by municipalities and preservation stewards because they are important to commercial and recreational fishing and as nurseries for aquatic species. Because of their ability to absorb storm energy (Costanza et al. 2008), wetlands are increasingly seen as a first line of defense against storm surge, adding to their value in land preservation. Although wetlands can migrate inshore with rising waters (Langley et al. 2009), several factors can affect their migration, including the rate of SLR, shoreline type, sedimentation rates, and property development. Narrow coastal areas can block migration pathways in nearshore areas (Kirwan et al. 2010). Without sufficient sediment supply, SLR may drown low marsh wetlands if migration pathways are blocked and wetlands are prevented from migrating landward as sea level rises.

Eelgrass is often used as an indicator of estuarine health and water quality (PEP 2009). Commonly found in shallow areas of high light penetration, eelgrass is already affected by water quality issues, harmful algal blooms (HABs), and boating (PEP 2009). Eelgrass may be critically stressed by SLR-induced changes in salinity, water temperature, and ultraviolet radiation (Short and Neckles 1999) if protection measures are not implemented.

Species Diversity and Populations

The great variety of habitats in the watershed supports diverse plant and animal species and populations. Rising average water temperature can alter the mix of species throughout the Peconic Estuary, and changing precipitation rates, as well as saltwater intrusion, have the potential to threaten species in the following ways:

- Warmer temperatures may result in an increase in non-native pests. SLR will increase saltwater intrusion, posing a threat to freshwater plants if saltwater extends landward beyond the current saltwater/freshwater interface, and changing precipitation patterns will affect plant growth (Kirwan and Gedan 2019)
- Ocean acidification will hinder the ability of calcifying organisms, such as shellfish, to build their shells or skeletons (Talmage and Gobler 2010)
- Climate change will affect the occurrence, types, abundance, distribution, and duration of HABs in the Peconic Estuary's waters (Griffith and Gobler 2019)

Water Quality and Watershed Effects

The Peconic Estuary's surface waters support valuable habitat, recreation, and fisheries. Groundwater is the primary source of drinking water for the surrounding communities and freshwater for the watershed's river, ponds, wetlands, and the Estuary itself (LaRoche et al. 1997). It also maintains the estuary's saline balance.

The watershed's surface water and groundwater, which are monitored and protected closely, face numerous pressures. Nutrients in groundwater (primarily from septic systems); contaminated runoff from impervious surfaces, lawns, agricultural areas, and golf courses; and atmospheric deposition of nitrogen have affected the Peconic Estuary's water quality (PEP 2007; Lloyd 2014). Nitrogen pollution is the most serious threat to the water quality of the Peconic Estuary, the main cause of hypoxia and HABs, and a contributing factor in the loss of critical eelgrass and wetland habitats (PEP 2007). Groundwater pumping has caused saltwater intrusion and reduced discharges to streams, ponds, coastal wetlands, and estuaries (USGS 2019). Climate change has the potential to exacerbate these issues in the following ways:

- Changes in precipitation—especially the projected increases in total precipitation and extreme rain storms—will likely lead to increased land-based and atmospheric inputs of nutrients (USEPA 2014; Sinha et al. 2017)
- Increased nutrient inputs plus warmer water may lead to more HABs, eutrophication, and hypoxia in salt and fresh surface water (PEP 2015; Griffith and Gobler 2019)
- SLR will likely result in the regular inundation of septic systems in coastal communities—either through higher tides or elevated groundwater levels—which could increase the amount of nitrogen and pathogens transmitted directly to estuarine waters (Suffolk County 2019)
- SLR has the potential to change the depth of the interface between freshwater and saltwater, which would threaten Long Island's drinking water supply and the Peconic Estuary's freshwater-fed habitats (USGS 2019)

DROWNED FORESTS

Along the world's coasts and in its estuaries, including along the southern shore of Flanders Bay, saltwater intrusion is overtaking the fresh water that deciduous trees need for sustenance. The higher salt content that results slowly poisons living trees, leaving a forest of dead and dying timber.

GENERAL APPROACH

The CRA included several distinct steps that built upon each other to better categorize and address the risks that climate change poses to PEP's management goals. This section provides a brief overview of the process. The project's methodologies and findings are detailed in Sections 2 and 3.

Stakeholder Outreach

Stakeholder outreach and involvement were critical parts of the CRA. PEP's strong stakeholder outreach program meant that stakeholder groups could be easily identified and tapped to provide feedback, guidance, and review. The following stakeholder meetings were held during the course of the CRA:

- Kickoff Meeting: January 29, 2018
- Developing Climate-Based CLPS Criteria: September 21, 2018
- Climate Change Vulnerability Assessment: January 7, 2019
- Vulnerability/Risk Assessment and CLPS Criteria Ranking Results: June 5, 2019

The meetings were attended by residents; staffers from towns, villages, and county offices and from regulatory agencies; elected officials; representatives of land use preservation and other non-profit organizations; and business leaders. PEP also consulted directly with its CAC and TAC members to promote outreach goals. Stakeholder comments were incorporated into the CLPS update and the vulnerability and risk assessment. Stakeholder outreach will not end with this report which, along with the tools presented in Section 4, will be distributed and promoted through social media and other channels. Appendix A includes notes and attendee lists from stakeholder meetings.

CLPS Update

To update the CLPS criteria and incorporate climate change, climate considerations were presented to a stakeholder group whose comments and concerns were documented. PEP then developed draft criteria and provided them to the stakeholder group. Additional comments were incorporated into a final set of updated criteria that was presented at the third stakeholder meeting.

To prioritize land for preservation based on the revised CLPS criteria, a ranking tool was developed and applied to individual parcels in the Peconic Estuary by mapping the data available for each criterion and the model projections of inundation levels and marsh migration under selected SLR scenarios. The parcel rankings were presented at the final stakeholder meeting. The data sources for each criterion are described in Section 2. All geospatial data were reviewed in accordance with the quality control checklist in the Quality Assurance Project Plan for this project (Anchor QEA 2017). This review is summarized in Appendix B.

Mapping completed under this project to identify the extent of climate risks informed the development of the new climate-ready CLPS. The ranking strategy to prioritize land use is part of the adaptation toolbox presented in this report. The climate-ready CLPS criteria are in Section 2.

Vulnerability Assessment and Climate Adaptation Action Plan

The vulnerability assessment and climate adaptation action plan are based on the process and tools outlined in *USEPA's Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans* (Workbook; USEPA 2014). The Workbook presents a process for identifying, analyzing, and comparing risks associated with climate change and climate change adaptation planning based on USEPA's experience with watershed management, the NEP, and the Climate Ready Estuaries program. Completing a risk assessment for the Peconic Estuary following the process laid out in the Workbook will enable the management team to address, through adaptation planning, the identified risks to program goals.

After developing a preliminary list of goals for its watershed management plans, PEP reached out to stakeholders to identify estuary-specific climate-based stressors and risks. To determine vulnerability, risks were ranked by their expected effect on PEP's ability to meet its management goals. The final step in the process was to develop a climate action plan to address vulnerabilities. The action plan includes strategies to address risk in a variety of forms and identifies where more work is needed to confront risks. The climate action plan is a "living document" that will be updated periodically to incorporate new climate change science, risks, and adaptation opportunities. Adaptation projects also include monitoring to assess the ability of individual actions to mitigate risks. Results of the vulnerability assessment are presented in Section 3.

SECTION 2:
CLIMATE-BASED CLPS CRITERIA AND RANKING TOOL

This section presents an overview of the new CLPS screening criteria development and prioritization process to account for anticipated changes in coastal conditions related to climate change. The objectives of the new climate-based CLPS criteria include continuing and building on the progress made by the original CLPS criteria so that vulnerabilities continue to be identified. The CLPS Ranking Tool, described in this section, was developed in response to the PEP TAC and CAC members' request for a tool that incorporates spatial mapping of the CLPS criteria datasets to develop measurable land protection goals.

DEVELOPING UPDATED CLIMATE CRITERIA

The revised CLPS criteria were built on the CLPS criteria developed in 2004, which are metrics to prioritize land acquisition and protection. The 2004 criteria are as follows:

- **Shoreline**: Prioritize preservation of land within 1,000 feet of the shoreline of a bay, tidal creek, or the Peconic River
- **Wetlands**: Prioritize preservation of land containing freshwater or tidal wetlands as identified by the U.S. Fish and Wildlife Service's 1994 National Wetlands Inventory
- **Critical Natural Resource Area**: Prioritize preservation of land in areas of particular ecological significance designated by PEP
- **Nitrogen-Stressed**: Prioritize preservation of land in a nitrogen-stressed subwatershed as designated by PEP

The Climate-Based CLPS Criteria Development Meeting of September 21, 2018, kicked off the update process (meeting notes can be found in Appendix A). The goal of the meeting was to develop revised criteria that will protect current and future habitats under climate change scenarios. Meeting facilitators presented the existing CLPS criteria and the anticipated regional climate change effects. They asked the participants to consider that, although the revised criteria will emphasize the health of the Peconic Estuary, stakeholder goals should be incorporated to the extent possible in order to promote the attainment of shared goals.

Participants agreed that PEP should revisit some of the datasets and sources used as a basis of the original criteria. There was also general agreement on the importance of including the existing criteria in the revised CLPS, with the exception of the Nitrogen-Stressed criterion which will need updating following completion of the Suffolk County Subwatersheds Wastewater Plan.[2] Because a primary factor controlling nitrogen loading to the Peconic Estuary is groundwater travel time, it was suggested that this metric be used in lieu of the Nitrogen-Stressed criterion.

The group identified the following additional parameters to be considered in the development of revised criteria:

- Protection/buffering of septic systems under SLR scenarios
- Protection of existing and migrating sandy shorelines
- Protection of natural shorelines, especially those with multiple functioning habitats
- Groundwater table depth
- Zoning lot size in relation to buffers
  - » Identifying sub-parcels
  - » Septic density
- Intensity of use/recharge rates
- Wetland/marsh migration
- Saltwater Intrusion

2) The Suffolk County Subwatershed Wastewater Work Plan study involved the identification of priority watersheds for nitrogen reduction based on nitrogen loading rates and receiving water residence times (Suffolk County 2019). The Work Plan is being used to develop a draft plan which was made available for public review in August 2019.

- Flood/coastal hazards zones under climate change scenarios, Federal Emergency Management Agency (FEMA) 100-year flood plains, New York State Department of Environmental Conservation (NYSDEC) Coastal Erosion Hazard Areas (CEHAs)
- Developed vs. undeveloped parcels

PEP revised the CLPS criteria based on input from the stakeholder group and, to the extent possible given available data and information, on the above parameters identified at the stakeholder meeting. The CLPS Ranking Tool (described below) was developed to prioritize land for protection based on the revised criteria. While the tool is based on available data and information, it is designed to incorporate new criteria as data become available.

Because many of these factors overlap, the revised CLPS criteria were grouped into the following classes:

- **Class 1: Habitat and Water Quality Protection.** The goals of the criteria in this CLPS class are to protect areas that currently support—or are predicted to support in the future—natural habitat (tidal and freshwater wetlands) in Peconic Bay, tidal creeks, and the Peconic River so they can continue to promote biodiversity and filter inputs of land-based nutrients to minimize incidents of dissolved oxygen stress.
- **Class 2: Inundation Areas.** The goals of the criteria in this CLPS class are to identify PEP program areas that would be submerged due to SLR so they may be considered for acquisition and to allow for wetland migration, restoration, or creation.
- **Class 3: Groundwater Protection.** The goals of the criteria in this CLPS class are to protect groundwater and to identify areas that may flood due to rising water tables so they can be prioritized for protection to reduce discharges of nutrients and contaminants into areas where groundwater travel times are short and to minimize damage from flooding. Other goals are to prevent saltwater intrusion into the water table and nonpoint-source pollutant discharges to the Peconic Estuary.

The criteria associated with each class are presented in Figure 3.

Figure 3: Climate-Based CLPS Criteria

Class 1: Habitat and Water Quality Protection

Contains or will contain freshwater or tidal wetlands

Located within 1,000 feet of the shoreline of a bay, tidal creek, or the Peconic River

Located within a Critical Natural Resources Area or a Significant Coastal Fish and Wildlife Habitat

Class 2: Inundation Areas

Located within a present-day flood zone

Located in areas that will become ununded under future sea-level rise projections

Class 3: Groundwater Protection

Located within a zone of groundwater recharge travel time area between 0–25 years

Located in areas with predicted increases in the saltwater interface elevation that will affect groundwater quality and elevation, causing flooding at the surface

Located in special groundwater protection area (100 + year recharge)

CLPS CRITERIA MAPPING

To evaluate the revised CLPS criteria, data representing each criterion were analyzed in a GIS framework. GIS permits a visual assessment of currently protected lands to help managers determine whether they meet new CLPS criteria, in order to identify and prioritize opportunities to protect adjacent unprotected areas and increase habitat connectivity. Mapping also identifies undeveloped areas and vulnerable developed areas that should potentially be targeted for acquisition or buyout.

PEP's approach to incorporating climate change considerations into the revised CLPS criteria included evaluations of impacts under three SLR scenarios. The scenarios were taken from the New York State Community Risk and Resiliency Act (CRRA) SLR projections, which were based on the 2014 ClimAID update (Horton et al. 2014). The CRRA projections were used because they include regional projections for New York State and have been adopted at the state level (6 New York Codes, Rules and Regulations [NYCRR] Part 490, Projected Sea-level Rise). Using accepted state projections ensures consistency with regulatory guidance and state grants. The selection process was also informed by SLR projections from other studies, including those conducted by the Intergovernmental Panel on Climate Change and the National Aeronautics and Space Administration. The CRRA projections for SLR in the Long Island region are presented in Table 1.

Table 1: CRRA Sea Level Rise Projections for the Long Island Region

Decades	Low	Low-Medium	Medium	High-Medium	High
2020s	2	4	6	8	10
2050s	8	11	16	21	30
2080s	13	18	29	39	58
2100	15	21	34	47	72

Note:
Source: 6 NYCRR Part 490, Projected Sea-level Rise. Inches of rise relative to 2000–2004 baseline.

The following SLR projections were selected by PEP for use in this analysis:

2020s: 6 inches | 2050s: 21 inches | 2100: 47 inches

The first projection, based on the medium CRRA projection for the short term, was selected because tide gauge data collected at Montauk appear to be tracking this scenario, having measured an almost 4-inch increase in SLR since 2000 (NOAA 2018). This scenario was used as the current condition because we are closer to the time period of the projection than to the 2000–2004 baseline. The medium- and long-term CRRA SLR projections for the 2050s and 2100 were selected from the medium-high scenario to provide upper bound estimates of SLR for future planning.

The SLR projections and predicted changes in coastal marshes were visualized using the Sea Level Affecting Marshes Model (SLAMM; NYSERDA 2017). SLAMM projections were performed under a grant from the New York State Energy Research and Development Authority (NYSERDA) by Warren Pinnacle Consulting using ClimAID SLR projections for several areas in the state including the Peconic Estuary (NYSERDA 2017). The SLAMM predictions were based on the selected SLR scenarios and other area-specific factors including hydrology and land cover.

The data sources for each criterion and for tax parcels in the Peconic Estuary are presented in Table 2. Figures 4 through 9 show the extent of inundation and marsh migration under each selected SLR scenario based on deterministic[3] SLAMM projections for 6 inches of SLR by 2025, 21 inches by 2055, and 47 inches by 2100. As the figures show, inundation areas (areas projected to flood at least once every 30 days) and marshes are predicted to move inland as a result of SLR. Future estimates of the depth to groundwater are limited to a single scenario, taken from CDM Smith as part of the Suffolk County Subwatersheds Wastewater Plan, in which SLR increases 34 inches; this estimate was considered in the 2100 SLR scenario. Figure 10 shows groundwater depths of 10 feet or less predicted under the 34-inch SLR and depths of 10 feet or less in 2016. Maps for the additional layers that represent additional CLPS criteria are provided in Appendix B.

3) SLAMM simulations are available as likelihood estimates (the probability of inundation and marsh changes under SLR scenarios) or for deterministic estimates of the ClimAID scenarios.

Table 2: Datasets Used in CLPS Analysis

Relevant CLPS Criteria/ Vulnerability Assessment Risk	Dataset	Source
Property boundaries, ownership information, and use codes	Suffolk County Tax Map Data	Suffolk County Real Property Tax Service Agency (2018)
Land use categories	Suffolk County Land Use	Suffolk County (2016)
Freshwater or tidal wetland	National Wetlands Inventory	US Fish & Wildlife Service (2018)
Inundation areas and sea level rise	SLAMM	NYSERDA/Warren Pinnacle Consulting, Inc. (2015)
Present-day flood zone	Digital Flood Insurance Rate Map Database, Suffolk County, New York	FEMA (2009)
Significant habitat and water quality	Significant Coastal Fish and Wildlife Habitats	NYSDOS (2015)
Current groundwater table	Depth to groundwater mapping	USGS (2016)
Rising groundwater table	Depth to groundwater after 34-inch SLR	Suffolk County / CDM Smith (2016)
Surface water protection	Groundwater travel time to surface waters	Suffolk County / CDM Smith (2016)
Special groundwater protection area	Critical Environmental Areas in NYS	NYSDEC (2016)

Figure 4: Inundation 2025 Medium Scenario (6" Sea Level Rise)

Figure 5: Inundation 2055 High-Medium Scenario (21" Sea Level Rise)

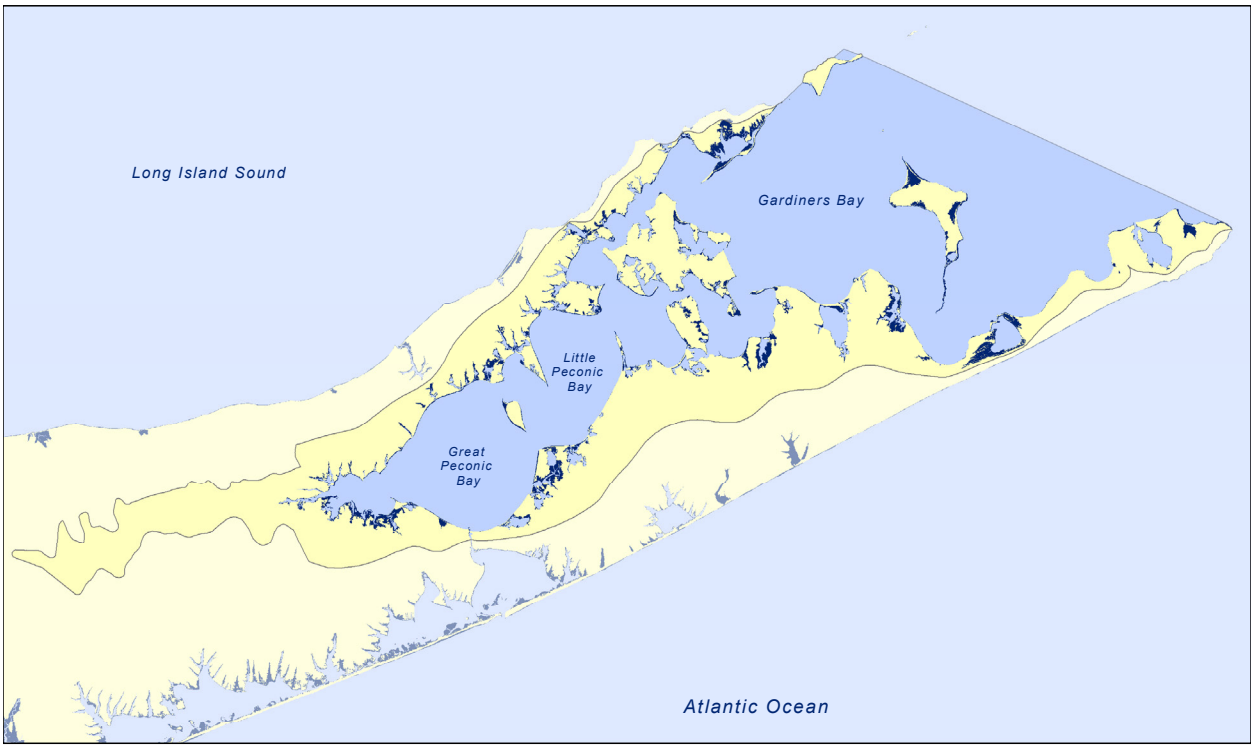


Figure 6: Inundation 2100 High-Medium Scenario (47" Sea Level Rise)

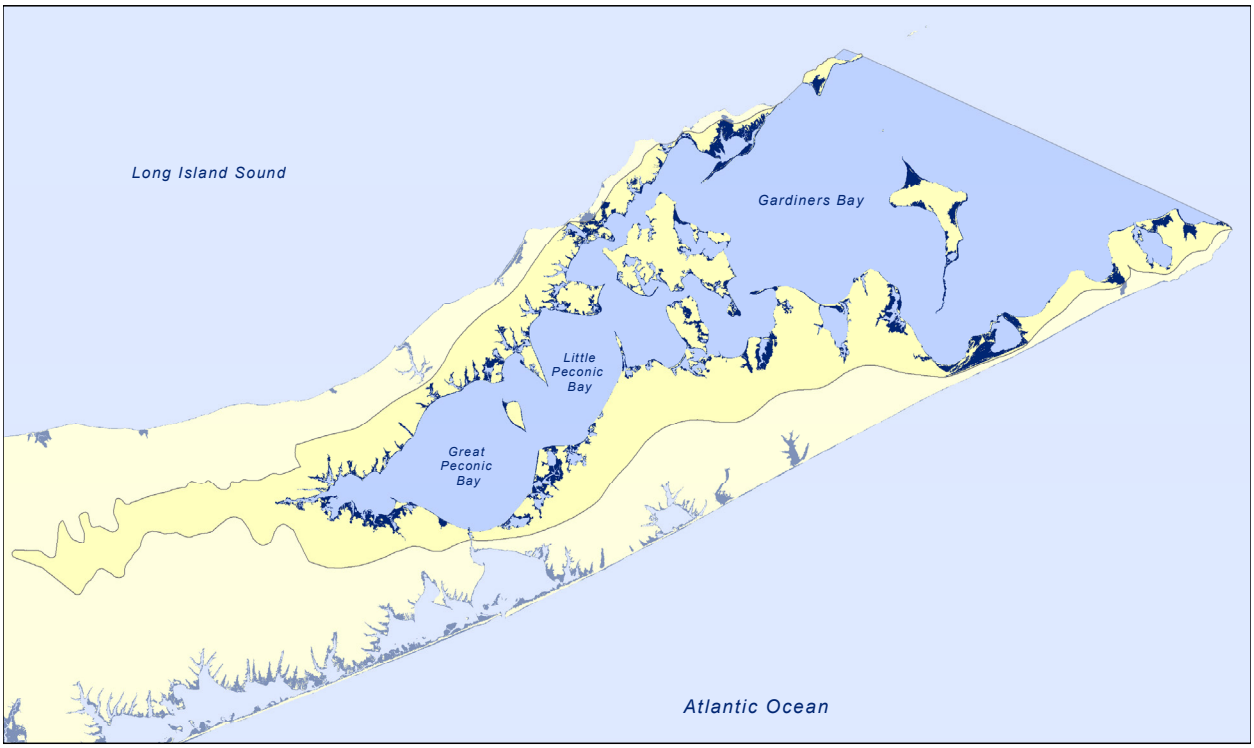


Figure 7: Future Tidal and Fresh Marsh Extent: 2025 Medium Scenario (6" SLR)

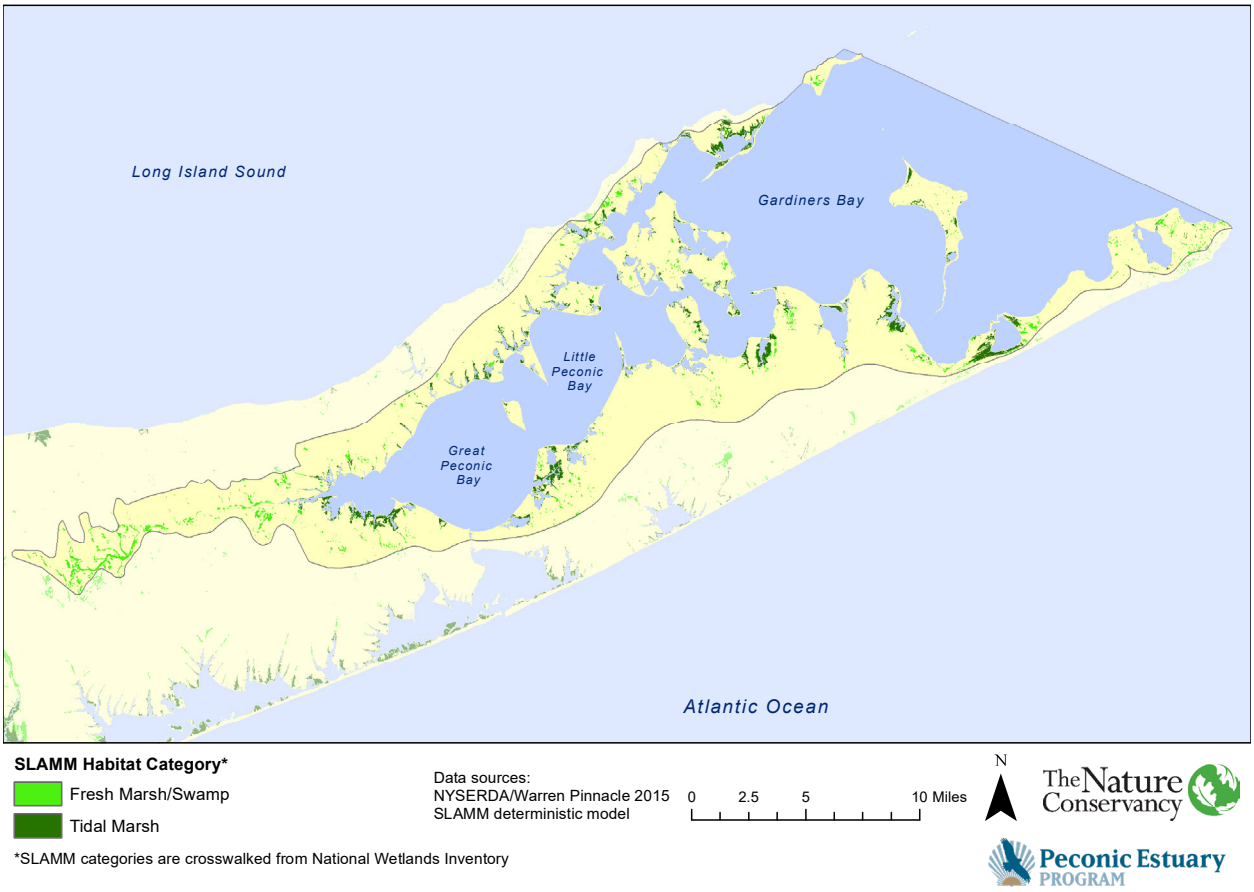


Figure 8: Future Tidal and Fresh Marsh Extent: 2055 High-Medium Scenario (21" SLR)

Figure 9: Future Tidal and Fresh Marsh Extent: 2100 High-Medium Scenario (47" SLR)

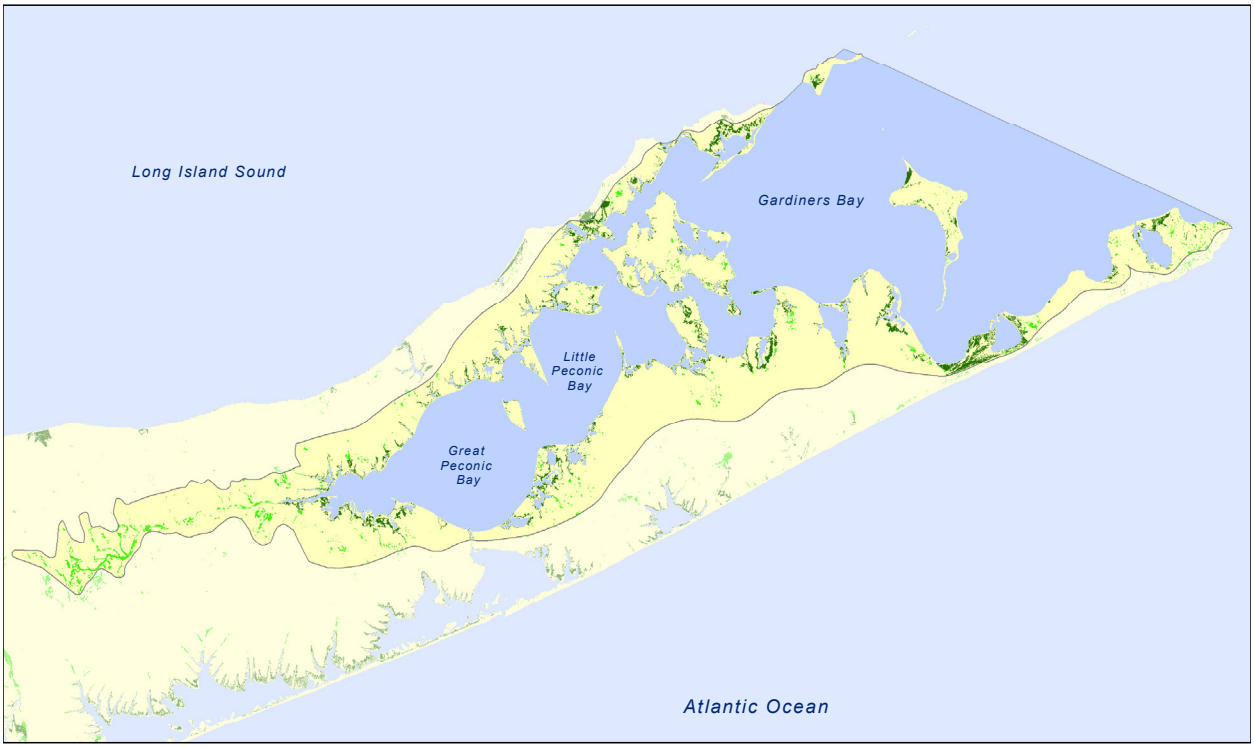
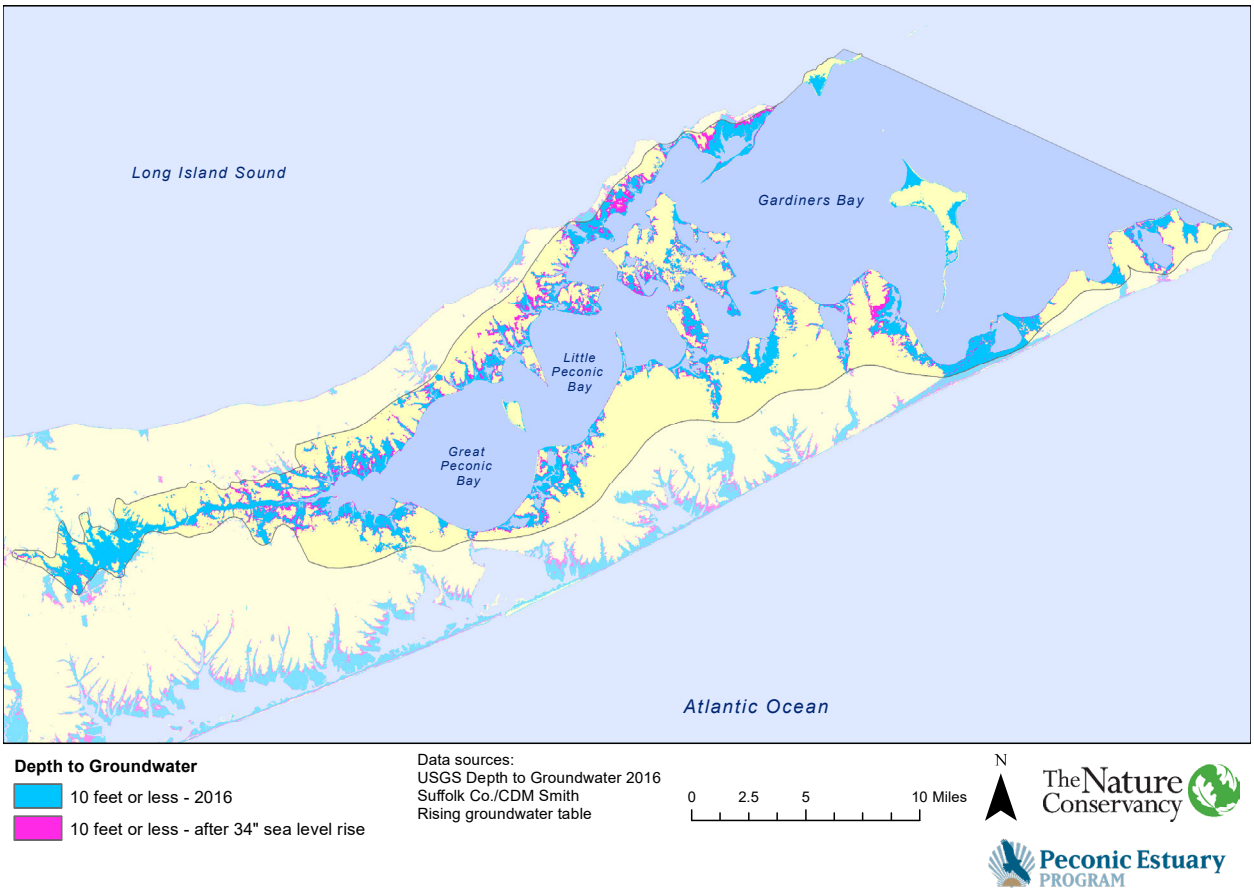


Figure 10: Shallow Depth to Groundwater (10 feet or less)



CLPS RANKING TOOL

The CLPS Ranking Tool provides a means of prioritizing parcels for protection by scoring them according to how many CLPS criteria they meet now or will meet under future SLR scenarios.

The CLPS criteria scoring was developed separately for "Undeveloped,""Developed," and "Agricultural" parcels. Undeveloped parcels include parcels designated on Suffolk County Land Use maps (2016) as "Vacant, Recreation & Open Space." Developed parcels include all other parcels except farmland, which is designated Agricultural on the Suffolk County Land Use maps. The scoring systems are described further at the end of this section.

Stakeholder Feedback

As first presented to stakeholders, the CLPS Ranking Tool designated parcels either "Developed" or "Undeveloped." The undeveloped parcels were parcels marked as Vacant, Recreation & Open Space on the Suffolk Country Land Use maps. Developed parcels were all other parcels including farmland. Many stakeholders questioned designating farmland as being developed.

Farmland is a new category in the CLPS process and did not fit neatly in either category. Although farmland preserves open space, varying levels of commercial development can occur on land zoned as agriculture. However, it is recognized that protected farmland is a distinct category of agriculture and is being pursued by the East End Towns to meet conservation goals. The CLPS Ranking Tool was designed to help decision makers not only decide which lands to acquire, but also evaluate which adaptation strategy is appropriate. For example, it may be possible to purchase additional conservation restrictions or easements on protected farmland in areas mapped as critical for marsh migration. However, it is important to carefully review and understand any existing conservation easements on protected farmland to ensure consistency with current conservation restrictions and requirements. It is also important that decision makers engage with the agricultural community as such strategies are considered.

Based on stakeholder feedback, farmland was categorized as "Agricultural" land and separated from parcels designated as "Developed" in the new CLPS ranking.

Note on Farmland and Conservation

Farmland can be preserved through a number of means, including the following: 1) the purchase of development rights (PDR); 2) the transfer of development rights (TDR); 3) the donation of conservation easements; and 4) the conveyance of a conservation easement as a condition of the approval of a subdivision. In most instances, the protected farmland remains in private hands while the development rights are held by a unit of government or a qualified conservation organization.

The Suffolk County Farmland Preservation Program, which dates from1974, was the first PDR program in the nation and has protected more than 10,500 acres of farmland to date. By the early 1980s, most East End Towns had established PDR programs of their own, usually funded by local bond issues supported by the public. In 1999, the Peconic Bay Region Community Preservation Fund was enacted through state legislation. It enabled the five East End Towns to collect a 2% real estate transfer tax to fund conservation acquisitions, including the protection of farmland as its highest priority. In all of these programs, the value of development rights is established by appraisals that represent the difference between the fair market value of a property based on its "highest and best use" (residential or commercial development) minus the value of the property limited to agricultural use (residual value). In all instances, the municipalities hold development rights documents (i.e., contracts or deeds), which are similar to conservation easements in form. TDR programs are a variation of the PDR concept in which municipalities permanently protect land that has conservation value (such as farmland, community open space, or other natural or cultural resources) by redirecting development that would otherwise occur on this land (known as the "sending zone") to an area planned to accommodate growth and development (known as the "receiving zone"). Such rights can be purchased by municipalities and held in a TDR "bank" for future sale to parties interested in increased residential or commercial density in a receiving zone.

The federal Tax Reform Act of 1976 included incentives to donate development rights on land of conservation value as defined in 170(h) of the Internal Revenue Code (26 U.S. Code § 170). Units of government and qualified conservation organizations (e.g., land trusts and conservancies) can accept donations of interests in real property in the form of perpetual conservation easements to protect shorelines, scenic vistas, endangered flora and fauna, and farmland based on clearly delineated governmental policy at all levels of government. The donor of these rights is eligible for a charitable deduction based on the difference between the value of the property with all its full rights intact (before value) and its restricted value (after value). As of 2016, more than 56

Continued on next page...

million acres nationwide have been protected by gifts of conservation easements. The Peconic Land Trust is a nonprofit, tax-exempt corporation whose mission is to conserve Long Island's working farms, natural lands, and heritage for its communities now and in the future. The Peconic Land Trust is a qualified conservation organization, as defined in the Internal Revenue Code, to acquire conservation easements by gift or purchase and to monitor and enforce those easements in perpetuity. Conservation easements can be tailored to protect the conservation attributes of specific property and to meet the goals, needs, and circumstances of a landowner.

In the late 1980s, the East End Towns began to incorporate clustering in their zoning codes to protect farmland through the subdivision process. Clustering requires that the development density allowed on a specific property be concentrated on a portion of the property, rather than its entirety. Cluster zoning is typically used to protect 35% to 70% of the prime agricultural soils on a farmland parcel through the use of a conservation easement. Such easements are not eligible for a charitable deduction because they are a condition of approval without charitable intent.

The Climate Adaptation Toolbox for Land Use and Municipalities Section on page 83 includes further information on the different strategies available for land use conservation in the Peconic Estuary.

Final Ranking Tool

Modeled after the existing CLPS prioritization strategy (PEP 2004), the CLPS Ranking Tool was modified to accommodate additional criteria organized by class and to incorporate climate change considerations. The prioritization categories for Undeveloped land are distinct from those for Developed and Agricultural land so that priority can be given to groups of Undeveloped parcels and to large Undeveloped parcels. Stakeholders expressed an interest in prioritizing smaller Developed parcels, so no priority was given to parcel aggregates and only limited priority was given to large Developed parcels. The tool assigns a score for each prioritization category and for each SLR scenario for which predictive data are available. Ranking parcels involves adding up the scores for each CLPS criterion a parcel meets; parcels that meet the most criteria will be ranked highest. Instructions for the CLPS Ranking Tool are provided on the following page.

HOW TO USE THE CLPS RANKING TOOL

The scoring system for Undeveloped land is shown in Table 3. The first category is for nearshore land, defined as land within 1,000 feet of the shoreline. If a parcel currently meets this criterion, 1 point is added to its score. If the parcel will also meet this criterion in 2055, under the 21-inch SLR, it gets another point, and it also gets another point if it will meet this criterion in 2100, under the 47-inch SLR.

Category 2, Priority Land Aggregates, is divided into a, b, and c categories, with points of 1, 2, or 3 if the parcel forms an aggregate of at least 10 acres and meets criteria from classes 1, 2, or 3 respectively. But because predictive data are not available for groundwater protection under the 2025 SLR scenario, the maximum number of points for Category 2 in this scenario is limited to 2 because it cannot be shown that a parcel may meet criteria from each of the CLPS protection classes. Points are assigned in the same manner for Category 3 (parcels of at least 10 acres), and Category 4 (parcels adjacent to protected land). The points for each category and SLR scenario are additive. Thus, the maximum score for an Undeveloped parcel is 27.

The scoring for Developed or Agricultural Land is similar, with differences in prioritization Categories 2 and 3. Rather than prioritizing aggregates, Category 2 includes parcels of any size that meet criteria from 1, 2, or 3 classes and Category 3 is limited to parcels that are greater than or equal to 10 acres and meet at least 1 criterion (there is no additional points for large parcel that meet additional criteria). Thus, the maximum score for Developed or Agricultural Land is 22.

Figure 11 shows how the individual scores for the CLPS categories are scored for a hypothetical Undeveloped parcel.

First, the parcel is currently within 1,000 feet of the shoreline and is predicted to be in 2055 and in 2100, so it gets 3 points for category 1. The parcel also meets the criteria for category 2c because it forms an aggregate of >10 acres and it meets at least 1 CLPS criteria from each class ((within the 100-year floodplain, has a tidal wetland, and groundwater table is at a depth of 10 ft or less on parcel), so it gets an additional 3 points added to its score. The parcel is also predicted to contain a freshwater wetland and be inundated by 2055, meeting the criteria for category 2b, so it gets another 2 points.

In 2100, the parcel is no longer predicted to have a tidal wetland, but it is predicted to be inundated and have a groundwater table at a depth of 10 ft or less so it gets another 2 points for category 2b. The parcel is not greater than 10 acres, so it does not get any points for category 3. It is adjacent to protected land greater than 2 acres, and it currently meets criteria for each of the 3 CLPS classes, so it gets 3 additional points, and will also meet both available criteria in 2055 and 2100, so it gets 4 more points. Adding up all these points, this hypothetical parcel gets a total CLPS criteria rank of 17.

Table 3: Undeveloped Land

Undeveloped Land Scoring System			
CLASS	CRITERIA		
	Current (6" SLR)	2055 (21" SLR)	2100 (47" SLR)
Provides Habitat and Water Quality Protection	Contains freshwater or tidal wetland	Will contain freshwater or tidal wetland	Will contain freshwater or tidal wetland
	Located within Significant Coastal Fish and Wildlife Habitat		
Identify Inundation Areas	Located within a flood zone		
	Inundation beyond shoreline	Inundation beyond shoreline	Inundation beyond shoreline
Groundwater Protection	Located within 0 - 25 year groundwater recharge zone		
	10' or less depth to groundwater		10' or less depth to groundwater*
	Located within a special groundwater protection area		

Prioritization Categories		**Score**		**Score**		**Score**
1: Nearshore undeveloped land:	Undeveloped land that is within 1,000' of the shoreline	1	Undeveloped land that will be within 1,000' of the shoreline	1	Undeveloped land that will be within 1,000' of the shoreline	1
2a: Priority land aggregates	Parcels of any size that contains one criterion	1	Parcels of any size that will contain at least one criterion	1	Parcels of any size that will contain at least one criterion	1
	Multiple parcels of any size that contains at least one criterion from two classes and forms an aggregate of >= 10 acres	2	Multiple parcels of any size that will contain one criterion from two classes and forms an aggregate of >= 10 acres	2	Multiple parcels of any size that will contain one criterion from two classes and forms an aggregate of >= 10 acres	2
2c: Priority land aggregates	Multiple parcels of any size that contains at least one criterion from three classes and forms an aggregate of >= 10 acres	3			Multiple parcels of any size that will contain one criterion from three classes and forms an aggregate of >= 10 acres	3
3a: 10 Up	Parcels >=10 acres that contains one criterion	1	Parcels >=10 acres that will contain one criterion	1	Parcels >=10 acres that will contain one criterion	1
3b: 10 Up	Parcels >=10 acres that contains at least one criterion from two classes	2	Parcels >=10 acres that will contain one criterion from two classes	2	Parcels >=10 acres that will contain one criterion from two classes	2
3c: 10 Up	Parcels >=10 acres that contains at least one criterion from three classes	3			Parcels >=10 acres that will contain one criterion from three classes	3
4a: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contains one criterion	1	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion	1	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion	1
4b: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contains at least one criterion from two classes	2	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from two classes	2	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from two classes	2
4c: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contains at least one criterion from three classes	3			Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from three classes	3
Maximum score = 27						

Notes:

Undeveloped = "Vacant, Recreation & Open Space" from Suffolk County Land Use 2016.

"Current" scenario relies on existing base maps (e.g., Significant Coastal Fish and Wildlife Habitat, FEMA mapping, groundwater recharge zones, groundwater protection areas) and the 6" SLR SLAMM estimates for inundation and marsh areas.

**Based on 34" SLR projection included in CDM groundwater model prediction.*

Table 4: Developed and Agriculture Land

Developed or Agriculture Land Scoring System			
CLASS	CRITERIA		
	Current (6" SLR)	2055 (21" SLR)	2100 (47" SLR)
Provides Habitat and Water Quality Protection	Contains freshwater or tidal wetland	Will contain freshwater or tidal wetland	Will contain freshwater or tidal wetland
	Located within Significant Coastal Fish and Wildlife Habitat		
Identify Inundation Areas	Located within a flood zone		
	Inundation beyond shoreline	Inundation beyond shoreline	Inundation beyond shoreline
Groundwater Protection	Located within 0 - 25 year groundwater recharge zone		
	10' or less depth to groundwater	--	10' or less depth to groundwater*
	Located within a special groundwater protection area		

Prioritization categories		**Score**		**Score**		**Score**
1: Nearshore developed land	Land that is within 1,000' of the shoreline	1	Land that will be within 1,000' of the shoreline	1	Land that will be within 1,000' of the shoreline	1
2a: Priority developed land	Parcels of any size that contains one criterion	1	Parcels of any size that will contain at least one criterion	1	Parcels of any size that will contain at least one criterion	1
	2b: Priority developed land	2	Parcels of any size that will contain one criterion from two classes	2	Parcels of any size that will contain one criterion from two classes	2
2c: Priority developed land	Parcels of any size that contains at least contains at least one criterion from three classes	3			Parcels of any size that will contain one criterion from three classes	3
3a: 10 Up	Parcels >=10 acres that contains one criterion	1	Parcels >=10 acres that will contain one criterion	1	Parcels >=10 acres that will contain one criterion	1
4a: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contain one criterion	1	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion	1	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion	1
4b: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contain at least one criterion from two classes	2	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain at least one criterion from two classes	2	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from two classes	2
4c: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contain at least one criterion from three classes	3			Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from three classes	3
4b: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contains at least one criterion from two classes	2	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from two classes	2	Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from two classes	2
4c: Adjacent to Protected	Parcels of any size that are adjacent to protected lands >= 2 acres and contains at least one criterion from three classes	3			Parcels of any size that are adjacent to protected lands >= 2 acres and will contain one criterion from three classes	3
Maximum score = 22						

Notes:

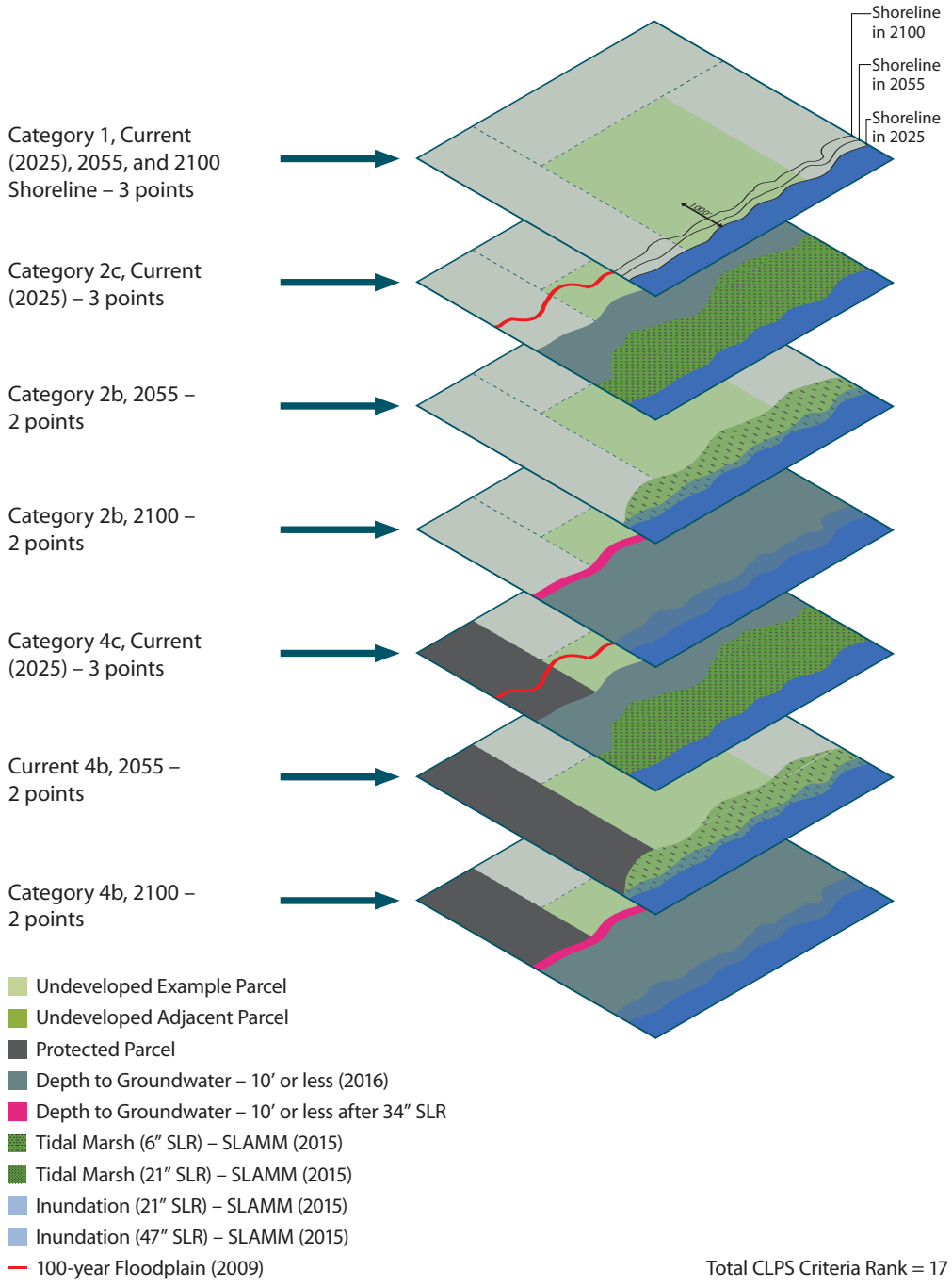
Built = Parcels that are categorized as land uses other than "Vacant, Recreation & Open Space" from Suffolk County Land Use 2016.

Agriculture = Parcels that are categorized as "Agriculture" from Suffolk County Land Use 2016. Contains conservation easements

"Current" scenario relies on existing base maps (e.g., Significant Coastal Fish and Wildlife Habitat, FEMA mapping, groundwater recharge zones, groundwater protection areas) and the 6" SLR SLAMM estimates for inundation and marsh areas.

**Based on 34" SLR projection included in CDM groundwater model prediction.*

Figure 11: CLPS Ranking Tool Example



The distribution of prioritization scores for Undeveloped land is shown in Figure 12. Figure 13 overlays the parcels that are already protected (parcels identified as Vacant or Recreation & Open Space in the Suffolk County Land Use layer and owned by a government entity [village, town, county, state, federal] or a land trust) on the results of the Undeveloped prioritization. A comparison of Figures 12 and 13 shows that most of the Undeveloped land in the highest CLPS prioritization category is already protected. The distribution of prioritization scores for Developed and Agricultural land, with the Protected Open Space parcel overlaid, is shown in Figures 14 and 15, respectively.

Figure 12: Undeveloped Priorization

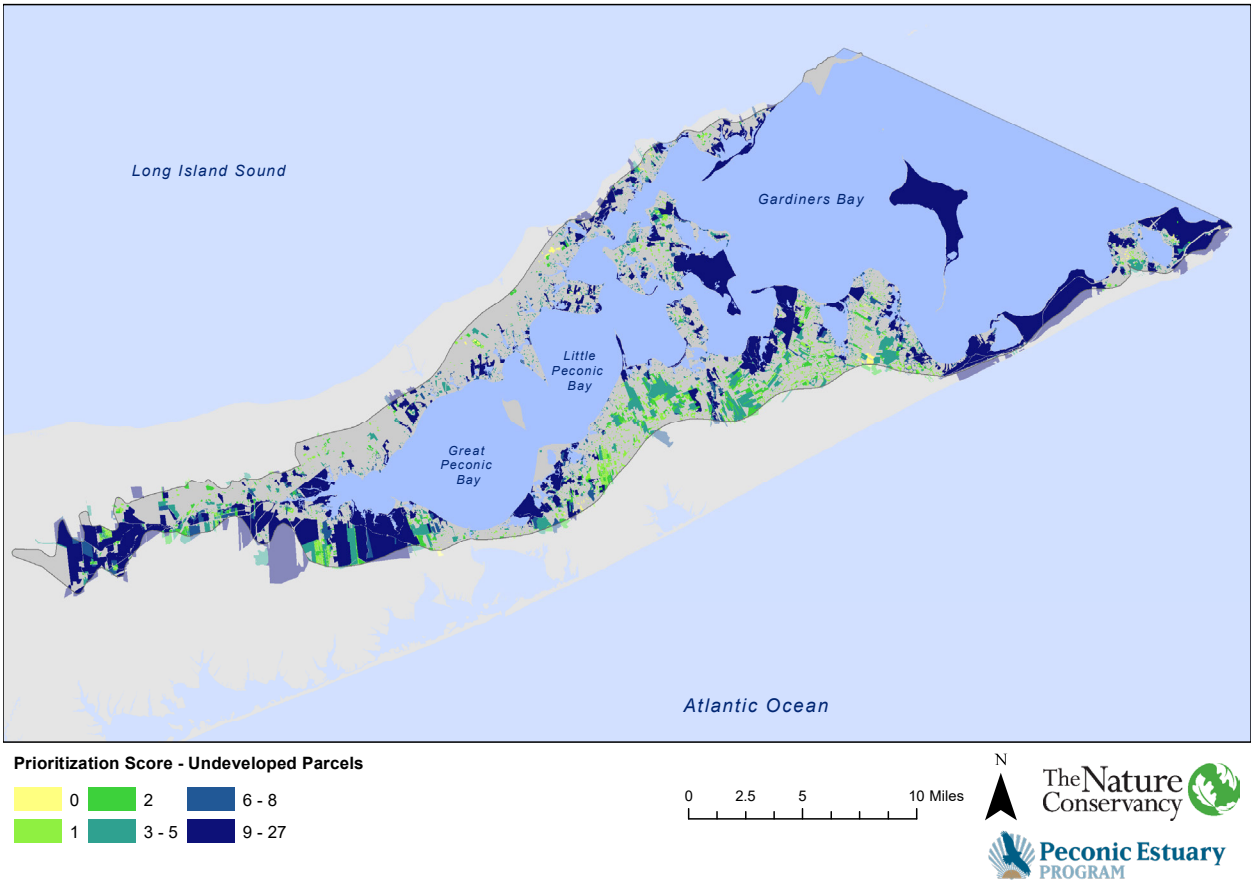


Figure 13: Undeveloped Priorization with Protected Open Space

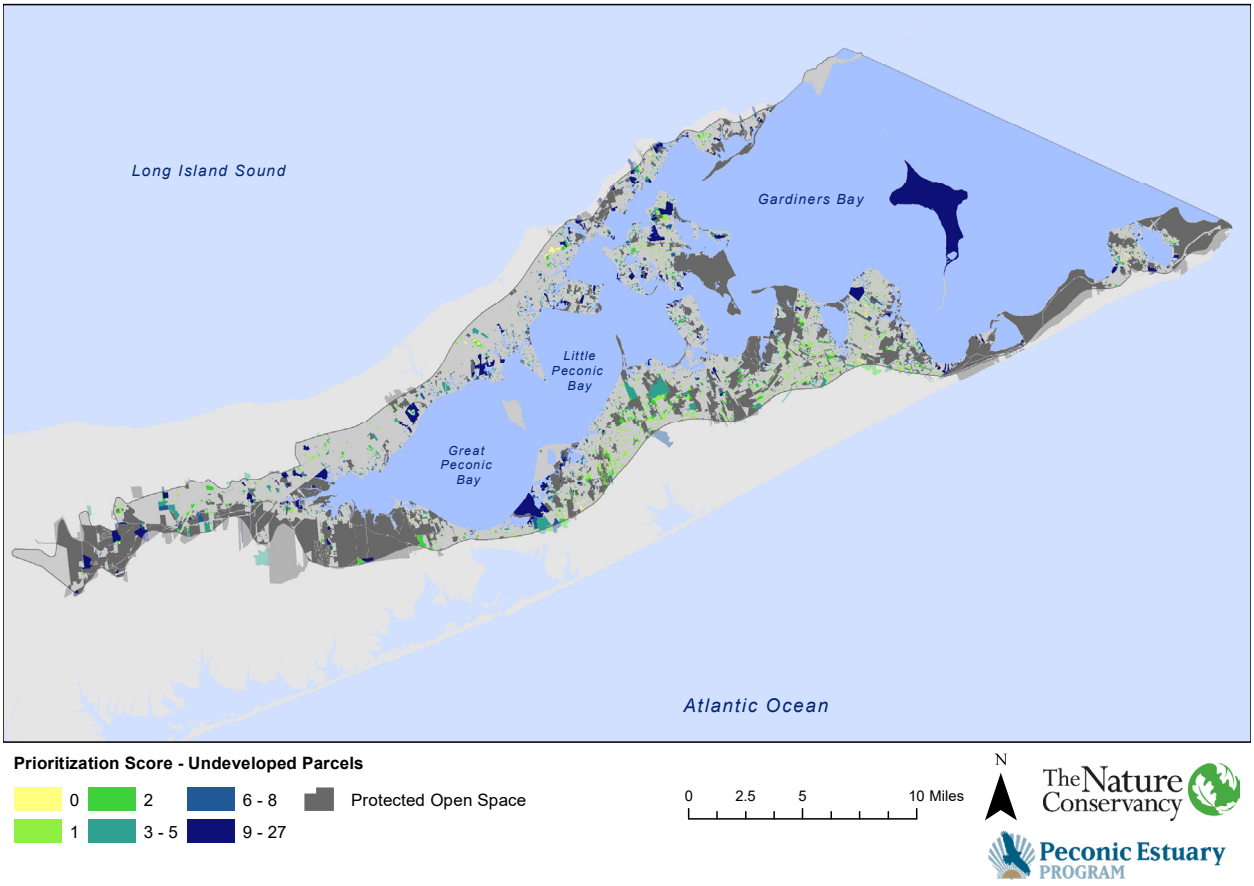


Figure 14: Developed Priorization with Protected Open Space

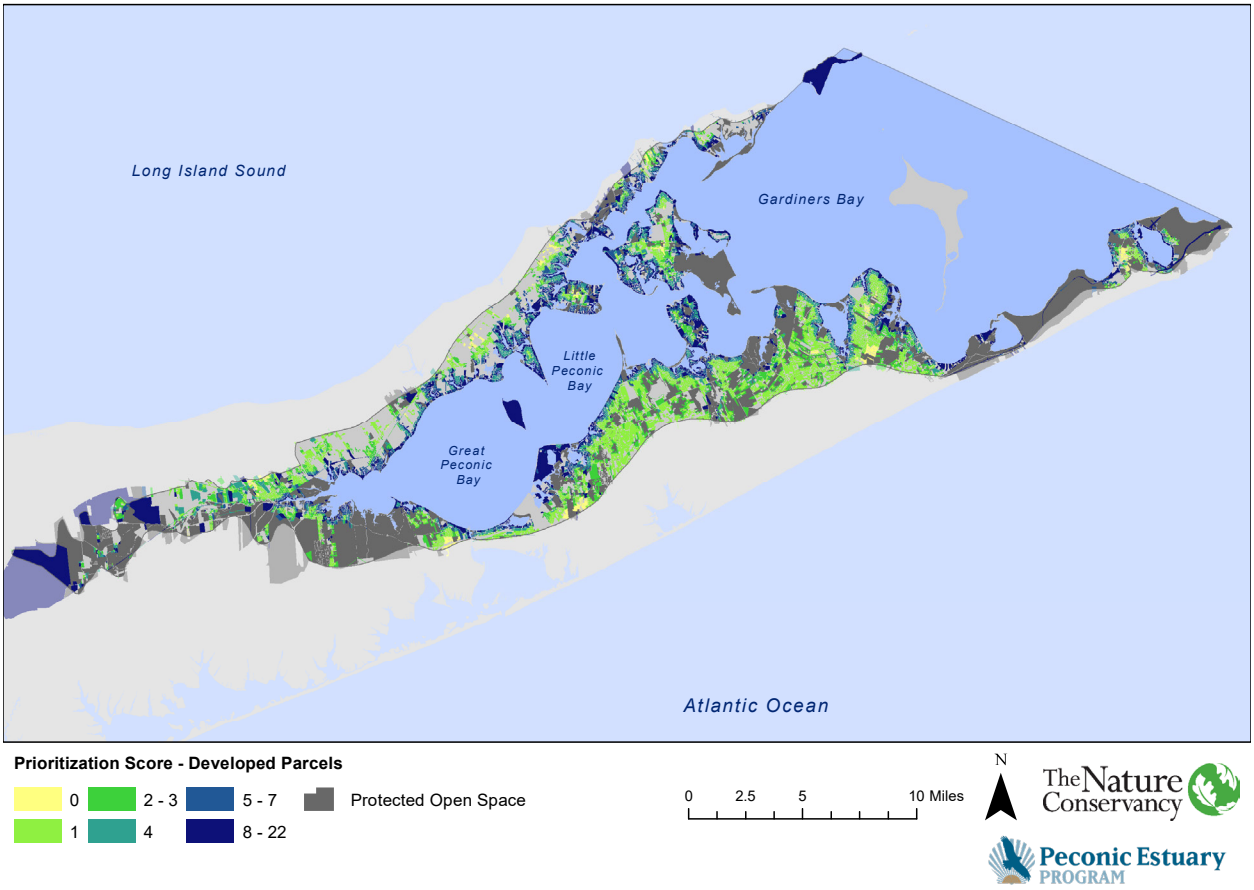
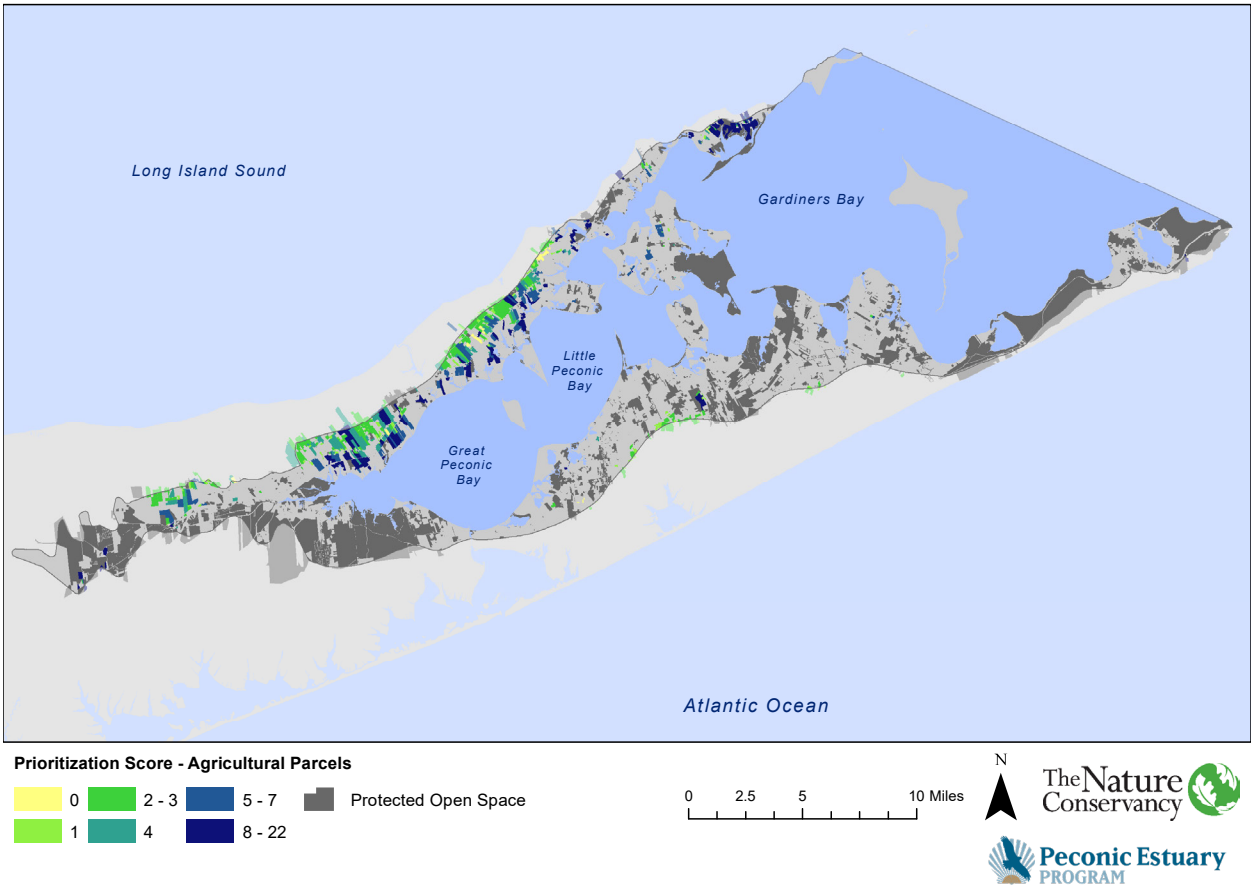


Figure 15: Agricultural Priorization with Protected Open Space



The distribution of scores for 54,963 parcels within the Peconic Estuary boundary and associated watershed is shown in Figures 16, 17, and 18 and in Table 5 for the Undeveloped, Developed, and Agricultural parcels, respectively. Because most of the parcels have a low CLPS ranking, priority parcels can be clearly distinguished.

Of the 10,215 Undeveloped parcels, 4,045 are already protected, and 750 of them have a CLPS criteria ranking score of 9 or higher, indicating there are numerous opportunities to advance climate change resilience in the Peconic Estuary. However, 357 of the 6,170 Undeveloped and unprotected parcels have a CLPS criteria ranking of 9 or higher; these parcels should be the focus of additional resilience measures.

Of the 745 agricultural parcels, 91 ranked 9 or higher and 125 are protected, either through Suffolk County's PDR efforts for farmland or jointly by Suffolk County and one of the towns. Of the 44,003 Developed parcels, 3,633 had CLPS ranking scores of 9 or higher. These parcels should be the focus of other resilience strategies such as land acquisition combined with infrastructure removal and with efforts to ensure their undeveloped portions remain undeveloped so marsh migration and other natural processes can occur.

Table 5: Distribution of Parcels

Parcel Category	Number of Parcels	High Priority Parcels (Rank of 9 or Higher)	Number of Protected Parcels	Protected High Priority Parcels (Rank of 9 or Higher)
Undeveloped	10,215	1,107	4,045	750
Agricultural	745	91	125	-
Developed	44,003	3,633	-	-

Note:
Source: 6 NYCRR Part 490, Projected Sea-level Rise. Inches of rise relative to 2000–2004 baseline.

Figure 16: Count of Undeveloped Parcels by Prioritization Score

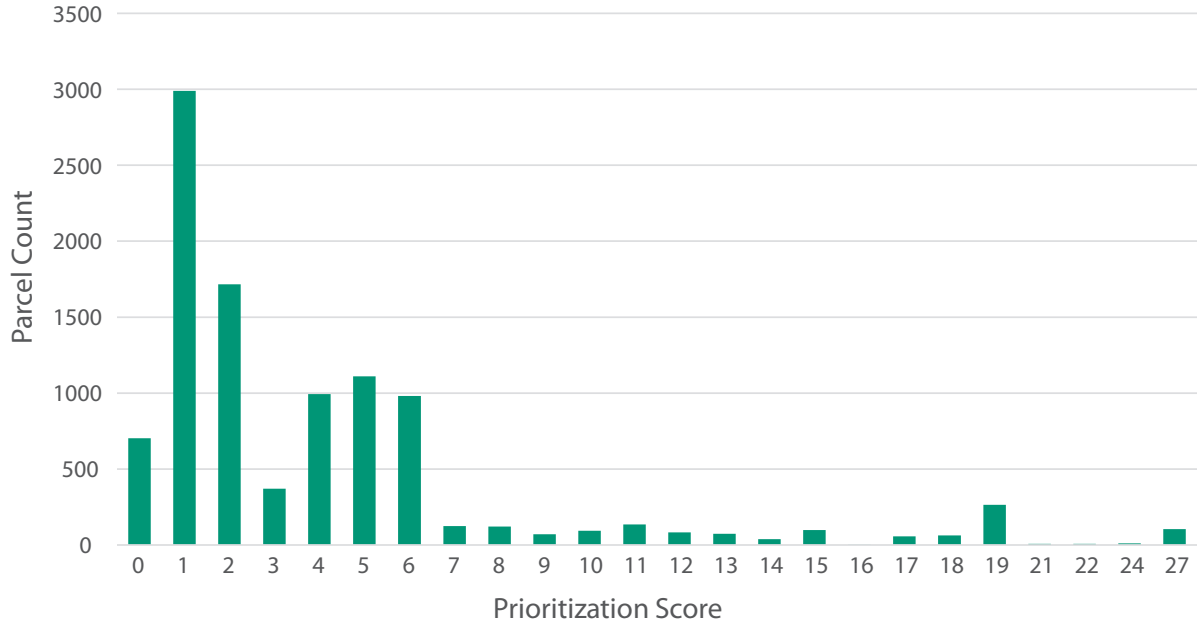


Figure 17: Count of Developed Parcels by Prioritization Score

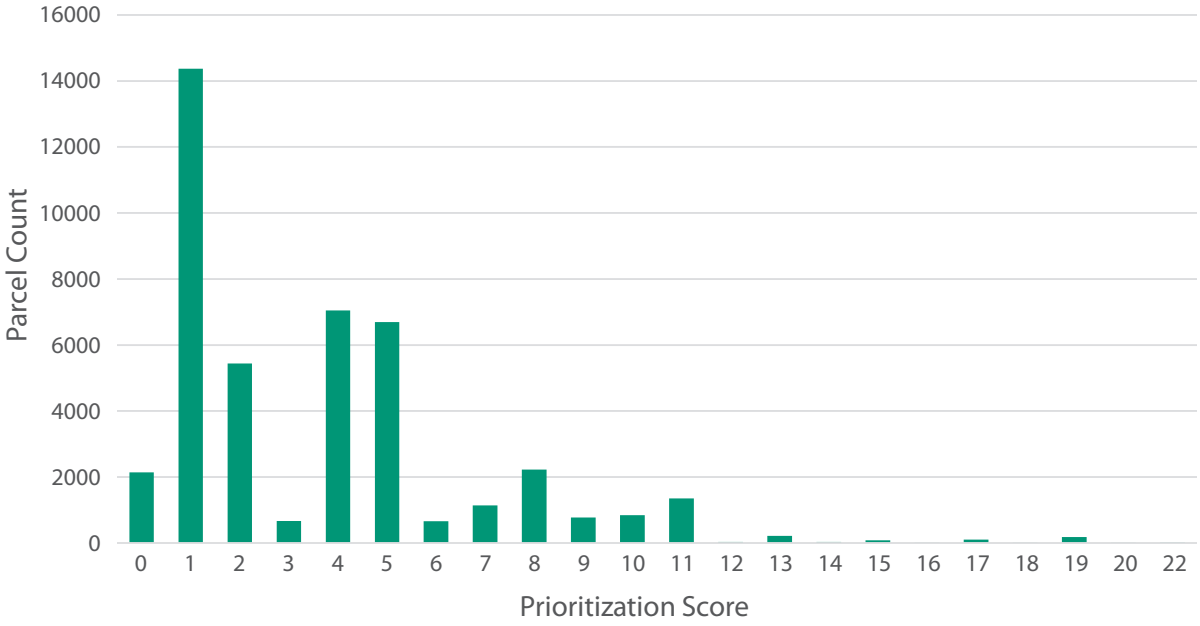
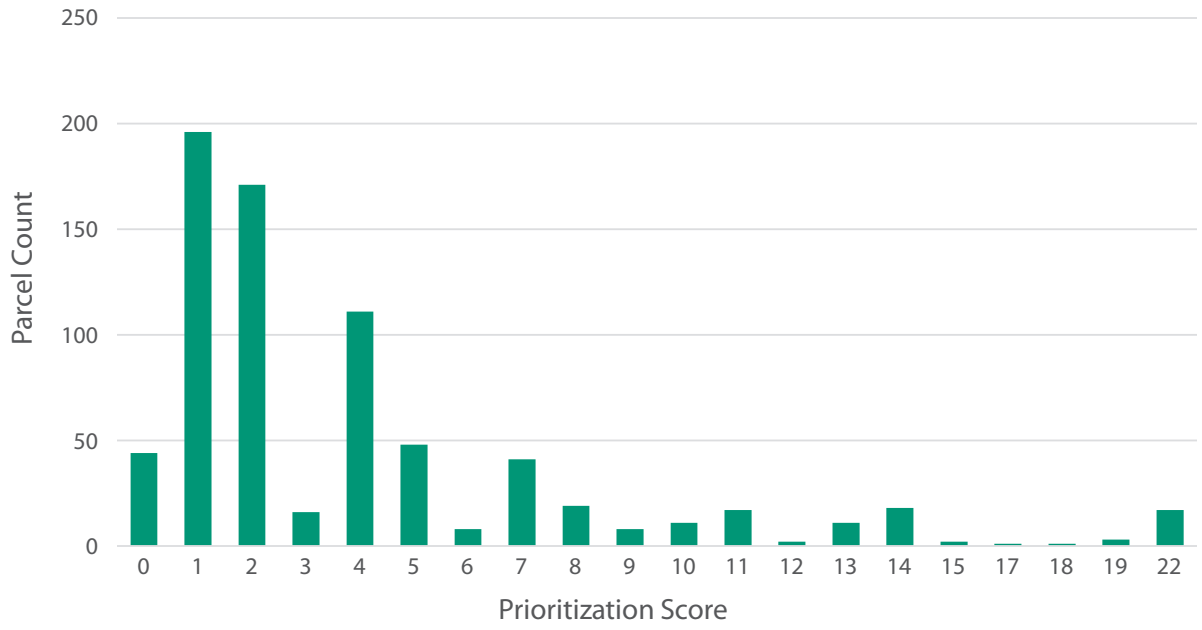


Figure 18: Count of Agricultural Parcels by Prioritization Score



SECTION 3:
VULNERABILITY ASSESSMENT AND CLIMATE ACTION PLAN

This section presents an overview of the vulnerability assessment and climate action plan for the Peconic Estuary. As discussed in Section 1, the vulnerability assessment used the process outlined in the Workbook to identify, categorize, and address climate risks. The Workbook provides a standardized risk management methodology to identify, analyze, and compare risks associated with climate change and a prioritization method to guide the selection of adaptation actions (USEPA 2014). The Workbook also includes an interactive online companion tool that guides users through the steps of creating a vulnerability assessment. The tool and its use in PEP's vulnerability assessment are described throughout this section.

The Workbook is based on NEP's cornerstone principles. It incorporates those principles by advancing a risk management approach that is appropriate for the scale of an estuary's watershed, by accommodating the large number of risks likely to be encountered, by encouraging collaboration with scientists and other experts to consider risks and their consequences, and by promoting a process **that is especially suited to public engagement and consensus** building.

NEP's Cornerstone Principles

- Focus on the watershed
- Integrate science into the decision-making process
- Foster collaborative problem solving
- Involve the public

CONTEXT FOR ASSESSMENT

For a subject as far-reaching as climate change, the first step in a vulnerability assessment is to set the context for analysis, which establishes the assessment's scope and boundaries.

PEP's priority management goals as defined in the 2001 CCMP and updated in response to stakeholder input were the context for its vulnerability assessment. The CCMP provided a framework for characterizing risks that might affect PEP's ability to achieve its management goals and the assessment endpoints for which PEP could develop, select, carry out, and monitor actions to address them. For example, although protecting transportation infrastructure is extremely important, it would not be considered part of PEP's vulnerability assessment because PEP has no authority to develop transportation infrastructure. But through a robust stakeholder process that includes municipalities and government agencies, PEP can identify how coastal wetland protection strategies could mitigate storm surges and help protect vulnerable inland infrastructure such as roads.

This process encourages collaboration and furthers PEP's role as a boundary organization.

PEP staff identified the following six initial goals against which climate risks could be assessed: protect habitat, protect water quality, maintain and enhance species diversity, protect groundwater, protect recreational activities, and promote sustainable fisheries. The goals were vetted and refined at a stakeholder meeting on January 7, 2019, and through follow-up conversations and outreach. Two additional goals: protect renewable/environmental infrastructure[4] and protect cultural resources, were added as a result of the stakeholder process. The goals used in this assessment are presented in Table 6.

4) Renewable/environmental infrastructure includes infrastructure that furthers PEP's management goals, such as new septic systems that reduce nitrogen loading and renewable energy that reduces carbon emissions.

Table 6: PEP Climate Vulnerability Goals

Habitat Protection Source: CCMP	***Detail*** Protect current and predicted areas of critical natural habitat (tidal wetlands, eel grass meadows, uplands and beaches and dunes) in the watershed.	***Protection Strategies*** • Provide buffers for migration and recharge • Protect existing habitat and indentify areas for reclamation for habitat migration and restoration • Prioritize natural engineering resilient/sustainable (non-hard) infrastructure
Water Quality Protection Source: CCMP	***Detail*** Protect water quality in the Peconic Bay, tidal creeks, and the Peconic River	***Protection Strategies*** • Reduce incidents of dissolved oxygen stress • Prevent non-point source pollutant discharge to the Peconic Estuary • Reduce incidents of harmful algal blooms: • Reduce Pathogen loading, • Reduce toxics, pharmacological products
Maintain and Enhance Species Diversity Source: CCMP	***Detail*** Protect and support increased biodiversity of native species in the Peconic Bay, tidal creeks, and the Peconic River.	***Protection Strategies*** • Promote biodiversity • Reintroduce native species • Control non-native/invasive species
Groundwater Protection Source: CCMP	***Detail*** Protect groundwater in Watershed.	***Protection Strategies*** • Maintain existing and protect future buffers to prevent saltwater intrusion to the groundwater table • Protect upland buffer zones

Recreational Opportunities Source: CCMP	***Detail*** Protect and promote recreational activities, within the Watershed.	***Protection Strategies*** • Provide and protect recreational access • Promote and protect recreational activities
Sustainable Fisheries Source: CCMP	***Detail*** Protect and promote sustainable fisheries, within the watershed.	***Protection Strategies*** • Protect and enhance habitat and food sources • Promote sustainability through public education
Renewable/ Environmental Infrastructure Source: Stakeholder Input	***Detail*** Protect and promote current and future mitigation strategies such as new septic systems, living shorelines, solar etc.)	***Protection Strategies*** • Fund projects (living shorelines) • Promote awareness through public education
Cultural Resources Source: Stakeholder Input	***Detail*** Protect and promote cultural resources and activities within the watershed.	***Protection Strategies*** • Provide and protect cultural resources • Promote and protect cultural activities

CLIMATE STRESSORS AND RISKS

The next step was to identify climate stressors, which are a broad category of climate change factors, such as SLR and more frequent and intense storms, that are considered in terms of their localized effect in a watershed. The Workbook lists six climate stressors to consider (USEPA 2014). PEP staff adopted the Workbook list for the Peconic Estuary and added a seventh stressor, rising groundwater, as follows:

- **SLR:** This climate stressor considers the effects of higher water levels at the shoreline, as well as the effect SLR may have on fresh surface water and groundwater in the Peconic Estuary watershed. This evaluation of the risks associated with this stressor uses information presented in Section 2, including the three ClimAID SLR scenarios and mapping results.
- **Warmer Waters:** This stressor considers the effects of higher water temperature on the chemical, physical, and biological characteristics of the Peconic Estuary's waterbodies, including the Peconic River and Peconic Bay. Ocean temperatures in the region are expected to rise between 4°F and 8°F over the next century. Because the watershed's main waterbodies are relatively shallow, they are expected to warm faster than the adjacent Atlantic Ocean and Long Island Sound (Horton et al. 2014).
- **Warmer Atmosphere/Changing Seasons:** This stressor considers the overall effects of warmer weather and changing seasonal patterns. Although weather patterns may cause periodic changes separate from climate change, overall mean temperatures in the Long Island region will increase by 3°F to 5°F by 2050 (Horton et al. 2014). The region is already experiencing cooler, longer springs, hotter summers, warmer falls, later and fewer hard freezes, and warmer winters with cycles of freezes and thaws and more precipitation falling as rain (NYSDEC 2015). These changes are expected to continue and magnify.
- **Increased Storm Frequency and Intensity:** This category of stressor includes all aspects of intensifying precipitation in any form, including more seasonal precipitation and higher rates and more total precipitation during storms. It also considers the effects of more extreme events such as nor'easters and hurricanes, the secondary effects from those events such as storm surge, and scenarios of more rain over longer periods. Precipitation is projected to increase 5% to 15% by the 2080s, with most of the increase occurring in winter. Intense downpours will likely become more frequent (NYSDEC 2015).
- **Increased Drought:** Drought is a deficiency in precipitation over an extended period. Precipitation rates in the Peconic watershed are expected to be higher, but longer periods of drought during the summer and fall are also expected (NYSDEC 2015). This climate stressor considers the effects of more frequent short-term droughts.

- **Ocean Acidification:** This stressor considers the effect of higher levels of carbon dioxide (CO2) in the atmosphere that dissolves into surface waters, affecting oceanic pH by creating carbonic acid. Over the past 300 million years, ocean pH has been slightly basic, averaging about 8.2. Today it is around 8.1, a drop of 0.1 pH units, representing a 20% increase in acidity over the past two centuries (National Geographic 2018). The effects of ocean acidification on the Peconic Estuary is an active area of study. Recent research predicts the collapse of the bay scallop population by 2100 based on expected increases in atmospheric CO2 levels and the resulting increased acidity of the water column (Grear et al. [in press]). Localized nitrogen contributions exacerbate these issues and speak directly to land use and waterfront development.
- **Rising Groundwater:** This climate stressor considers the effect of rising groundwater on upland resources and the Peconic Estuary's waterbodies. The watershed's groundwater levels are expected to rise as a result of increased precipitation and pressure from SLR. (Denser sea water will push against the coastal interface, causing the less dense groundwater to rise up. Because Long Island is a relatively narrow coastal moraine with numerous bays and inlets, this pressure will be especially evident in the Peconic Estuary watershed [USGS 2019).

Once PEP identified its management goals and climate vulnerability stressors, the next step was to identify the risks each climate change stressor posed to attaining PEP's management goals. Risks are the reasonably foreseeable ways that climate change stressors could get in the way of the goals identified in Section 3. The risks were first identified by PEP staff (following a presentation on the risk assessment process), by stakeholders who participated in a workshop, and through direct outreach to partners. Table 6 presents an example of some of the risks identified for habitat protection by the seven climate stressors. Appendix A includes all the risks to all of PEP's goals. All management goals, climate stressors, and risks were entered into the Workbook's online companion tool.

Table 7: Example of Risk Assessment: Potential Effects of Climate Stressors on Habitat Protection Goal

Sea Level Rise

SLR may flood/drown wetlands. If wetlands are not able to migrate, sea level rise could lead to wetland habitat loss.

SLR will increase eelgrass bed depths, decreasing sunlight penetration.

SLR will decrease nearshore habitat areas (beaches, tidal flats, etc.) if such habitats are not able to migrate.

SLR may increase connections between marine and groundwater systems and lead to secondary impacts on critical habitats.

SLR may increase saltwater intrusion rates changing habitat types, especially in buffer areas.

Warmer Waters

Warmer waters may decrease eelgrass viability.

Warmer waters may affect wetland viability (fresh and tidal wetlands)

Warmer waters may affect DO levels in marine and freshwater systems, especially shallow rivers, streams, and creeks with low flushing

Warmer waters may lead to increased temperature stratification.

Warmer water may change patterns and risk of HABs

Rising Groundwater Table

Rising groundwater may bring non-point sources closer to the Peconic Estuary

Rising groundwater may lead to habitat changes (ponding)

Rising groundwater may lead to more freshwater ponds, leading to more vector control (pesticides, mechanical control), which could have a secondary impact on habitat

Warmer Atmosphere/ Changing Seasons

Warmer atmosphere/changing seasons may change plants' ranges (affecting habitats).

Warmer atmosphere may lead to more rain.

Changing seasons may lead to less snow

More Frequent and Intense Storms

More frequent and intense storms will increase erosion of shoreline and nearshore habitats.

Increased storm frequency and intensity storms will lead to more stormwater runoff/ and flooding into the Peconic Estuary, increasing non-point pollution and turbidity, and decreasing water clarity in nearshore habitats.

Increased Drought

Times of drought will reduce freshwater input into tidal wetlands, upland habitats and beach habitats.

Increased drought will decrease river flows.

Increased droughts will reduce growing seasons in upland watershed areas.

Increased drought may stress land-based species and lead to more foraging which could have a secondary effect on buffer habitat.

Ocean Acidification

Increased acidification may affect the suitability for shellfish, fish, and other species that also serve as habitat.

Coastal acidification may be magnified through synergies with reduced DO, increased nutrients etc.

RISK CATEGORIZATION AND VULNERABILITY ASSESSMENT

The final step of the assessment process was to rank the risks to determine vulnerability. For each risk identified, PEP staff and stakeholders considered, on a qualitative scale, the following metrics outlined in the Workbook: consequence, likelihood, time horizon, spatial extent, and habitat type (USEPA 2014). The qualitative scale enabled staff and stakeholders to use a variety of resources in making vulnerability determinations, including the quantitative databases used to generate the maps in Section 2, stakeholder outreach, expert consultations, available data, and scientific reports. It also enabled them to weigh considerations such as PEP or partners' ability to influence an outcome. A risk's consequence and likelihood were ranked qualitatively as high, medium, or low. A risk's time horizon was ranked as "already occurring/0 to 10 years", "10 to 30 years", or "30 years or more"; higher vulnerability was attributed to the risks likely to happen sooner. Spatial extent was ranked by site, place or region, or extensive.

Descriptions of the metrics PEP staff and stakeholders used in considering each identified risk are as follows:

- **Consequence:** Each risk was considered against its perceived consequence for the watershed or PEP resource within the watershed. Consequence was ranked as high if the risk's effect presented as a major disruption and the goal in question could no longer be attained. A low consequence risk would need some attention but could easily be managed within the current management framework.
- **Likelihood:** The chance that a risk will occur is its likelihood. This metric considered current regulations, known management strategies, and planned projects. High likelihood meant a risk was seen as all but certain to happen even when known management strategies and projects were considered. A low likelihood meant a risk had the potential to happen, but its occurrence was unlikely based on known management strategies, specific environmental conditions, or research.

- **Time Horizon Until the Problem Begins:** The time horizon categorized risk in terms of immediacy; risks expected to occur sooner were ranked higher than future risks with unknown time horizons.
- **Spatial Extent of the Impact:** The spatial extent categorized a risk in terms of its geographic scope in the Peconic Estuary watershed using the following sub-categories:
  - » Site (e.g., individual waterfront lots, a protected parcel)
  - » Place or region (e.g., Peconic River, creeks, beaches, open water)
  - » Extensive (most of the watershed or most of the Peconic Estuary)
- **Habitat Type:** Habitat type was considered, but did not affect ranking. This factor was used more to flag risks unique to critical habitats.

The results of the ranking using USEPA's prioritization scheme were entered into the online tool. The tool automatically generates a consequence/probability matrix and a table of risks ranked as high (red), medium (yellow), and low (green). High risks were ranked as follows: high consequence and high likelihood, high consequence and medium likelihood, or medium consequence and high likelihood. Risk tables are provided on the following pages.

Goal: Protect Habitat

Likelihood (probability) of occurrence				
	High	1. Warmer atmosphere may lead to more total precipitation, and more in the form of rain.	1. Warmer atmosphere/changing seasons may lead to an increase in invasive species. 2. Warmer waters may decrease eelgrass viability. 3. 3Warmer waters may affect freshwater systems, especially shallow rivers, streams (mainly due to reduced dissolved oxygen). 4. Increased drought may decrease Peconic River and tributary flows and may limit freshwater input into brackish systems. Lower flow could affect diadromous fish if there are reduced flows during their migration period. 5. Increased droughts during growing seasons may affect species in upland watershed areas. 6. Increased storms will increase erosion of shoreline habitat and eelgrass. 7. Sea level rise may increase the depth of eelgrass bed, which will decrease the amount of sunlight reaching the eelgrass.	1. Sea level rise will flood/drown wetlands. If wetlands are not able to migrate inland, sea level rise could lead to wetland habitat loss. 2. Sea level rise will decrease nearshore habitat areas (beach, tidal flats etc.) If nearshore habitat areas are not able to migrate, could lead to habitat loss. 3. Increased ocean acidification may affect the suitability for shellfish, fish, eelgrass and other species that also serve as habitat.
	Medium	1. Rising groundwater may lead to habitat changes (ponding). 2. Times of drought may reduce freshwater input into tidal wetlands. 3. Increased drought may stress land based species and lead to more foraging/grazing which could have a secondary affect on habitat. For example, deer foraging may increase which may lead to overgrazing. 4. Sea level rise will increase saltwater intrusion changing habitat type. For example, saltwater intrusion may pose a threat to diadromous fish that need freshwater habitats for spawning and nursery areas.	1. Rising groundwater may increase connectivity between groundwater and surface waters systems. More connectivity may affect water quality (less land based filtering/buffering) and lead to more saltwater intrusion. 2. Rising groundwater may lead to more freshwater ponds, leading to more pressure to control vectors. Use of more pesticides and mechanical control could have a secondary impact on habitats, especially wetlands. 3. Warmer atmosphere/changing seasons may change the range of native plants (affecting habitats). 4. Warmer water species may change existing habitats. 5. Times of drought may affect freshwater systems in terms of temperature (more pronounced temperature changes in shallower systems). 6. Increased storm frequency and intensity storms will lead to more stormwater runoff/and flooding into the Estuary, increasing non-point pollution and turbidity, and decreasing water clarity in nearshore habitats. 7. Sea level rise may increase connections between marine and groundwater systems and lead to secondary impacts on critical habitats (example: increased connectivity may increase availability of non-point source pollution into habitats). 8. Coastal acidification may be magnified through synergies with reduced dissolved oxygen, increased nutrients etc.	
	Low	1. Warmer atmosphere/changing seasons may lead to less snow. 2. Warmer waters may affect wetland viability. Warmer waters may exacerbate nutrient loading. 3. Warmer waters may lead to stratification.		
		Low	Medium	High
		Consequence of impact		

Goal: Maintain and Enhance Species Diversity

Likelihood (probability) of occurrence				
	High		1. Warmer atmosphere/changing seasons may affect species diversity/loss.	1. Warmer atmosphere/changing seasons may allow pests to survive winter. 2. Warmer waters may decrease eelgrass viability. 3. Warmer waters may affect freshwater species, especially in shallow creeks, portions of the Peconic River and streams (warmer waters, reduced dissolved oxygen). 4. Sea level rise may decrease species range and habitat (beach, wetlands, tidal flats etc.) areas if not able to migrate.
	Medium	1. Warmer waters may support non-native species.	1. Increased drought may stress land based species (water availability, increased foraging on plants). 2. Drier climate may increase invasive species (for example, southern pine beetles). 3. More frequent and intense storms may lead to erosion/loss of species habitat.	
	Low		1. Rising groundwater may lead to more freshwater ponds.	1. Increased drought may decrease connectivity between systems (especially freshwater).
		Low	**Medium**	**High**
		Consequence of impact		

Goal: Protect Water Quality

Likelihood (probability) of occurrence				
	High		1. Increased storm frequency and intensity storms may lead to more storm water runoff into the Estuary, increasing non-point pollution and turbidity, and decreasing water clarity. 2. Sea level rise may bring septic systems/sewers/storm drains closer to estuary waters, increasing nitrogen, pathogen and toxics loading.	1. Warmer atmosphere/changing season may result in longer growing seasons, which may result in more inputs of chemicals and nutrients into estuary (due to increased fertilizer and pesticide use). 2. Sea level rise may bring homes and other infrastructure closer to estuary waters and habitat, decreasing areas for migration/ buffering.
	Medium	1. Warmer waters may increase non-native species. 2. Increased droughts may increased pressure to irrigate (increased irrigation may cause dewatering of local adjacent wells).	1. Rising groundwater tables increases risks of infrastructure affecting water quality (septic systems/sewers). 2. Increased droughts may reduce freshwater water levels which could lead to more DO issues (warmer waters). 3. Increased droughts may decrease freshwater flow limiting fres.hwater input into brackish systems 4. Sea level rise may bring increase saltwater intrusion into brackish and freshwaters systems.	1. Warmer waters may lead to prolonged algal blooms and increases in HABs. 2. Warmer waters may affect species used to improve water quality (shellfish, marine plants). 3. Coastal acidification may affect shellfish viability, which will affect water quality. 4. Coastal acidification may affect marine plants viability, which affects water quality.
	Low	1. Warmer atmosphere and changing seasons may result in species shifts which could affect water quality. For example increases in geese population could add nutrients and pathogens from waste.	1. Drier climate may support high levels of invasive species. 2. Increased droughts may reduce connectivity between systems (especially freshwater).	
		Low	**Medium**	**High**
		Consequence of impact		

Goal: Protect Groundwater

Likelihood (probability) of occurrence				
	High		1. Increased storm frequency and intensity storms may lead to more storm water runoff into groundwater (water may bypass stormwater treatment/ flood sumps).	
	Medium		1. Warmer atmosphere/changing season will result in longer growing seasons, which may result in more inputs of chemicals and nutrients into groundwater (from increased application of fertilizers and pesticides etc.). 2. Sea level rise will reduce the available land area for groundwater recharge to occur, especially in areas where there is high levels of impermeable development. 3. Sea level rise may reduce areas that act as buffers to saltwater intrusion into groundwater. 4. Rising groundwater may increase connectivity between systems (especially freshwater), which could affect mixing and water quality.	1. Increased droughts may decrease recharge to groundwater table.
	Low			
		Low	**Medium**	**High**
		Consequence of impact		

Goal: Protect and Promote Sustainable Fisheries

Likelihood (probability) of occurrence				
	High		1. Increased use of resources with longer warm water season may lead to more recreational/commercial fishing con-flicts/pressure. 2. 2. More frequent and intense storms may cause more runoff and patho-gens, toxics and pharma into waters (increased shellfish closings). 3. 3. Sea level rise may affect upland recreational infrastructure (access, facilities, infrastructure).	1. Sea level rise may decrease wetland and other nursery habitats if not allowed to migrate.
	Medium	1. Warm waters may support new fish-eries.		1. Rising groundwater may bring septic systems/nitigogen/runoff sources closer to estuary, increasing inputs and result in in more HABs. 2. Warm waters may lead to decreased stocks of current species. 3. Increased drought may affect freshwa-ter input into the Estuary, which may affect freshwater fisheries. 4. Coastal acidification may affect shell-fish, fin fish fisheries. 5. Coastal acidification may affect habitat that supports fisheries (wetlands/ eelgrass etc), and habitat created by fisheries (shellfish).
	Low			
		Low	**Medium**	**High**
		Consequence of impact		

Goal: Protect and Promote Recreational Activites

Likelihood (probability) of occurrence				
	High		1. Warmer atmosphere/changing season may result in species changes affecting recreational hunting and fishing. 2. Warmer atmosphere/changing season may result in extreme heat/poor air quality, increased pollen may reduce recreational access. 3. Increased storm frequency and intensity storms result in increased runoff and pathogens into waters affecting swimming and recreational fishing.	1. Sea level rise may decrease beach areas if not allowed to migrate. 2. Sea level rise may decrease public access if existing areas are not allowed to migrate. 3. Sea level rise may affect upland recreational infrastructure (access, facilities, infrastructure) and resources (trails, parks).
	Medium	1. Warmer waters may result in changes to recre-ational fisheries (species changes). 2. Longer periods of warm weather may result in increased recreation for longer time and could lead to increased use of resources.	1. Rising groundwater tables could increase flooding at public parks 2. Warmer atmosphere/changing season may affect coastal bird populations (birding). 3. Warmer atmosphere/changing season may result in increased ticks, mosquitos and other vector populations with warmer temperatures, less winter freezes and more ponding, resulting in recreational fear/more pesticide use. 4. Increased storm frequency and in-tensity storms result in more erosion, which could lead to more maintenance dredging pressure to support marinas, navigation channels etc.	1. Warmer waters may increase brown tide and HABs will affect swimming and recreational fisheries. 2. Increased acidification may affect the suitability for shellfish and fish, affecting recreational fisheries and water quality (swimming).
	Low	1. Increased drought will decrease river flows, which may affect recre-ational use of systems.		
		Low	**Medium**	**High**
		Consequence of impact		

Goal: Protect Renewable Infrastructure

Likelihood (probability) of occurrence				
	High			
	Medium		1. Rising groundwater may flood new I/A OWTS septic systems. 2. Sea level rise may result in flooding/loss of living shorelines. 3. Sea level rise may result in loss of wetland restoration projects.	1. More frequent and intense storms may cause erosion/loss of living shorelines, wetland restoration projects.
	Low			
		Low	**Medium**	**High**
		Consequence of impact		

Goal: Protect Cultural Resources

Likelihood (probability) of occurrence				
	High			
	Medium	1. Coastal acidification may lead to decreased populations of historically important fin-fish and shellfish fisheries.	1. Warm waters may reduce populations of culturally important fisheries. 2. Coastal acidification may lead to decreased populations of culturally important fin-fish and shellfish fisheries.	1. Rising groundwater may lead to ponding/flooding in areas near cemeteries/historic landmarks within estuary boundaries.
	Low			1. More frequent and intense storms may cause flooding and erosion at cemeteries and historical landmarks within estuary boundaries. 2. Sea level rise may cause flooding of cemeteries, historic landmarks.
		Low	**Medium**	**High**
		Consequence of impact		

As the Workbook risk tables show, many of the risks are not only related but also have the potential to build on each other. For example, SLR may amplify the risk of rising groundwater tables, and vice versa, because rising water along the coasts and in groundwater systems may lead to more flooding during storms than SLR or rising groundwater alone. Because systems are connected, a single climate stressor will affect more than one resource. One challenge of risk based vulnerability analysis is to address the nuances of the stressor under consideration while also addressing the connections between systems. Because the magnitude of the effects of climate change is uncertain, regular monitoring and further research must be part of any adaptation plan. Some of the highest risks to the watershed are discussed below, organized by climate stressor. Because some of the risks in the Workbook tables are similar across climate stressors, several of the risks have been combined.

Sea Level Rise

The greatest risk to the Peconic Estuary's management goals posed by SLR is two-fold: SLR will reduce the area of coastal habitats if they are unable to migrate landward, and it will cause saltwater intrusion. These occurrences will affect PEP's ability to protect habitat, water quality, species diversity, groundwater resources, and recreational access. The risks in this category ranked high because in many places the built environment extends to the edge of the Peconic Estuary, which restricts the natural ability of habitats to adapt to rising water levels, and groundwater is the region's sole source of drinking water. Land preservation will be instrumental in ensuring buffers are available to allow habitat migration and prevent saltwater intrusion.

High risks include the following:

- SLR will flood or drown coastal habitat (e.g, beach, wetlands, tidal flats).
  - » SLR will lead to habitat loss if these habitats cannot migrate landward.
  - » SLR may decrease species ranges if those habitats are unable to migrate.
  - » SLR will increase the depth of surface water where eelgrass beds exist, which would decrease sunlight penetration, and in turn, could lead to eelgrass loss.
- SLR will mean that homes and other built infrastructure are located closer to Peconic Estuary waters and habitat, thereby decreasing the areas available for habitat migration or buffering between the natural systems and built environment and increasing the potential for associated non-point source pollution.
- SLR may increase connections between groundwater and surface waters and between stormwater and surface waters.
- SLR may reduce the area available for recreational access and may flood or otherwise damage recreational infrastructure and resources (e.g., trails, beaches, parks).

Increased Storm Frequency and Intensity

More frequent and intense storms will lead to more stormwater entering the Peconic Estuary's surface water and groundwaters and to erosion of the nearshore habitat. All of this will affect PEP's ability to protect habitat and water quality. Natural shorelines have the potential to mitigate some of these risks; wetlands provide flood storage, storm surge attenuation, and erosion control, and they may benefit from the movement of sediment during storms. Riparian lands provide buffers, but pressure to harden shorelines to protect built infrastructure reduces the area for natural shoreline and habitats and may lessen the ability of the remaining areas to act effectively. Adaptation strategies to protect and restore nearshore areas and emphasize soft engineering approaches will be necessary to reduce these risks.

The greatest risks from more frequent and more intense storms are the following:

- Inundation of septic systems, resulting in the leaching of wastewater and the closure of shellfish beds
- Damage to shoreline habitat and eelgrass beds
- Increased stormwater runoff into the Peconic Estuary, leading to increased non-point source pollution and turbidity
- Increased stormwater runoff into groundwater (water may bypass stormwater treatment or flood sumps)
- Damage to species-management structures (such as fish ladders) or habitat and to wetland restoration projects (such as living shorelines)

Sea Level Rise
Increased Storm Frequency and Intensity
Warmer Atmosphere/ Changing Seasons
Warmer Waters
Increased Drought
Rising Groundwater
Ocean Acidification

Warmer Atmosphere/Changing Seasons

Higher mean average temperatures will affect species diversity as seasonal patterns shift faster than some species can adapt. While the focus of global climate change is often warmer summers, higher winter temperatures are the most dramatic shift seen thus far in the northeast (Mufson et al. 2019). Warmer weather for longer periods may mean some migratory species of animals and birds that were only in the Peconic Estuary during warm times of the year, may be present for longer periods and in numbers that may stress native species populations. Warmer spring, summer, and fall seasons may also lead to increased use of resources. For example, although a longer growing season may benefit agricultural resources and food availability, without comprehensive fertilizer and pesticide controls, longer periods of active agriculture may mean a net gain of nutrients and chemicals in the Peconic Estuary through runoff and stormwater discharges. Or consider recreational fishing, which may continue beyond the traditional high summer season. Such risks will affect PEP's ability to protect species diversity and water quality.

Although some uncertainty is inherent in these risks, species monitoring and management must figure prominently in adaptation strategies to address high risks such as the following:

- Reductions in species diversity through longer warm seasons and shorter cold seasons
- Increased numbers and levels of invasive species and the greater ability of pests to survive winter, adding pressure on native species
- Longer growing seasons that may result in more chemicals and nutrients in runoff to the Peconic Estuary from lawns, golf courses, and agriculture
- Longer periods of extreme heat and poor air quality, which may reduce recreational access
- Increased use of resources during longer warm weather seasons, which may lead to more recreational and commercial fishing conflicts and pressure
- Changes in the species present, affecting recreational hunting, fishing, and aquaculture (shellfish)

Warmer Waters

One consequence of a warming atmosphere will be warming waters, which may support some of the risks identified above related to species diversity and loss in addition to risks associated with specific chemical and physical properties of water. Warmer water expands, which leads to additional SLR. Like a warm can of soda, warmer water also carries fewer gasses, and can lead to stratification within the water column. Warmer waters may also lead to an increase in HABs. These occurrences will affect PEP's ability to protect habitat, water quality, species and diversity, and recreational access. The risks in this category ranked high because water quality and coastal habitats are vital resources to PEP and the region. Water quality controls will be necessary to help mitigate some of the effects of warmer water. Land preservation and conservation will also be necessary to allow habitat migration due to SLR. High risks include the following:

High risks of increased ocean and coastal acidification include the following:

- Warm water fish species moving north and into local waters. Although such migration could increase species diversity, if warmer water species displace native fish populations, overall species diversity may decrease.
- Increased temperature stratification of the water column may be especially problematic in western reaches of the Peconic Bay, which receive less flushing than the eastern reaches.
- Warmer water may fuel HABs, especially in surface water ponds and lakes because many cyanobacteria exhibit optimal growth and bloom potential at high water temperatures relative to other aquatic plants (Tufts 2017).

Sea Level Rise
Increased Storm Frequency and Intensity
Warmer Atmosphere/ Changing Seasons
Warmer Waters
Increased Drought
Rising Groundwater
Ocean Acidification

Increased Drought

Although overall precipitation rates in the region are expected to increase, more of the precipitation will likely fall in the winter and spring as rain, while the summer and autumn will experience periods of drought. These trends will affect PEP's ability to meet groundwater protection goals and may reduce species diversity in freshwater and brackish systems.

High risks of increased drought include the following:

- Decreased flows in the Peconic River and its tributaries, which may limit freshwater input into creeks and Peconic Bay
  - » Lower flows during their migration period could affect diadromous fish.
  - » Increased salinity could affect fish and plant species
- Disrupted growing seasons in upland watershed areas

Rising Groundwater

Some groundwater rise may be caused by increased precipitation. Pressure from SLR will also be a factor in groundwater rise, and it has the potential to bring the systems closer even in times of drought. The biggest risk to PEP's water quality goal from rising groundwater is cross contamination of freshwater and saltwater systems. Although adaptation measures promoting buffers may help mitigate some risks, saltwater intrusion presents a huge risk to a variety of habitats and to water for drinking and irrigation.

High risks of rising groundwater include the following:

- The potential to bring inputs from septic systems, cesspools, and nonpoint sources closer to the Peconic Estuary, possibly resulting in more HABs
- Increased connections between saltwater and freshwater systems

Sea Level Rise
Increased Storm Frequency and Intensity
Warmer Atmosphere/ Changing Seasons
Warmer Waters
Increased Drought
Rising Groundwater
Ocean Acidification

Ocean Acidification

This is an area of active research in the region, and some of the full effects of ocean acidification are still being studied. Lower pH poses a high risk to species with shells and exoskeletons, and emerging research shows that high levels of carbonic acid may also harm finfish. Although many aquatic plants may benefit from lower pH (Koch et al. 2013; Young and Gobler 2016), some may benefit more than others (Young et al. 2018). With shellfish aquaculture being promoted in the region to support commercial fisheries and increase water quality, ocean acidification may affect PEP's ability to manage and protect species diversity, water quality, habitat, and sustainable fisheries.

High risks of increased ocean and coastal acidification include the following:

- Impacts on the suitability of Peconic Bay for shellfish and fish, which in turn affect species diversity and commercial and recreational fishing
- The viability of shellfish, which will affect water quality
- The bloom-forming macroalgae *Ulva* may outcompete the seagrass *Zostera marina* (Young et al. 2018)

Sea Level Rise
Increased Storm Frequency and Intensity
Warmer Atmosphere/ Changing Seasons
Warmer Waters
Increased Drought
Rising Groundwater
Ocean Acidification

ADAPTATION STRATEGIES

The goal of adaptation planning is to reduce the risk climate change poses to PEP's resources and management goals. As shown in the risk tables, many risks overlap because many of the goals are interconnected and climate stressors are additive. These overlaps require careful consideration to ensure the full scope of a risk is identified, but they also provide opportunities for adaptation strategies to address multiple issues. PEP's adaptation planning followed the process outlined in the Workbook, which guides users to select high-level approaches for managing risks. Because resources are limited, ranking risks as high, medium, or low enables the development of an effective adaptation plan based on prioritization. Responding to high risks is the top priority because they are very likely to happen and will have high impacts when they do. Medium and low risks are not ignored, but they can be addressed in the future or as capacity allows. Many times, because systems are connected and dynamic, addressing high risks will also address—or at least begin to address—medium and low risks.

The first step in adaptation planning involved identifying potential adaptation actions and strategies to address high risks; the actions and strategies identified as part of the CRA are described below and the results of a screening evaluation are provided in the next section.

Actions

Selected adaptation actions include projects that emphasize soft or green engineering to restore and enhance natural system and habitat functions and are amenable to the incorporation of design elements that can mitigate the effects of climate change. Nature-based solutions work with and enhance nature to help people adapt to change and disasters. By working with the natural environment and mimicking natural processes, nature-based solutions provide multiple benefits to the environment. They are often more cost effective than hard structural responses, and they offer added flexibility in responding to climate change impacts.

PEP and its partners are using many of these strategies to protect water quality and habitats. Considering the effects of climate change in current and future project designs is key to their ongoing success. For example, stormwater retention ponds should be designed to store the additional rain from the more frequent and more intense storms expected in the future. Wetland restoration projects

should include upland migration zones, if available. Besides improving coastal resiliency and erosion control, living shorelines and other nature based solutions can improve water quality by filtering pollutants in runoff, and they can create or maintain important habitat, improve waterfront access and recreational opportunities, and enhance aesthetics. Climate action elements can be added to current habitat restoration planning. For instance, the creation of deep pools that protect the subsurface from sunlight and help to lower water temperature could be added to planned restoration projects in the Peconic River. These deeps pools would provide a refuge or habitat for warm-water-sensitive species and would enhance the resilience of restored habitats in the face of warming waters.

PEP has a long history of success with habitat restoration projects. Several are now underway, and additional priority projects that have been identified, as described in the Peconic Estuary Program Habitat Restoration Plan (PEP 2017). A summary and status of each of these projects are available on PEP's website (https://www.peconicestuary.org/news-and-blogs/maps-gis/habitat-restoration/). These projects support each of the habitats in the Peconic Estuary, including deep open water communities, the deep Peconic mud basin, shallow embayments, submerged aquatic vegetation, tidal wetlands, tidal flats, sandy beaches and dunes, freshwater habitats, and upland forests and grasslands. Their goal is to restore ecosystem function and reduce the negative impacts on the Peconic Estuary's valuable and unique habitats caused by increasing population density, development, navigational dredging, shoreline hardening, boating, fishing, pollution, and invasive species. Habitat restoration is critical to reduce the effects of these threats and to enhance the Peconic Estuary's resilience to climate impacts. The maps created for this project will help identify and inform areas for future habitat creation and restoration projects, and upland land conservation strategies discussed later in this report can help ensure such projects continue to function and flourish as sea levels rise.

Several adaptation action projects are described in more detail in the following sections.

LIVING SHORELINES

Living shorelines are a nature-based approach to shoreline stabilization that provide a cost-effective, ecologically preferable alternative to hardened shorelines. They have the potential to reduce the risks climate change poses to virtually all of PEP's management goals. Unlike hardened shorelines, living shorelines are constructed from natural materials such as wetland plants, oyster reefs, sand, and stone. These materials help stabilize shorelines while providing habitat for aquatic and coastal species (NYSDEC 2017).

PEP has contracted with the Cornell Cooperative Extension and the Peconic Land Trust to construct living shoreline pilot projects in Greenport and Southold, New York. The Greenport project was completed in August 2019. It will be monitored to assess its efficacy in providing storm resilience and coastal habitat, to determine changes in elevation of the shoreline over time to identify the gain or loss of sand, and to gauge the growth of smooth cordgrass (Spartina alterniflora) and American beachgrass (Ammophila breviligulata).

Additionally, PEP has contracted with Cornell Cooperative Extension to construct a living shoreline pilot project that incorporates smooth cordgrass and ribbed mussels at the Suffolk County Marine Environmental Learning Center in Southold. This project is expected to be completed in August 2020. The project will be evaluated to determine its ability to provide storm resilience and coastal habitat, as will the shoreline's effectiveness in reducing nitrogen and pathogen inputs to the Peconic Estuary.

Homeowners can use elements of living shorelines to reduce reliance on bulkheads and other hard engineering structures, especially along creeks with low to moderate wave energy and gradual slopes. There, native plants can be used to stabilize the shoreline with their roots and provide habitat for fish and wildlife.

PEP and its partners will continue to provide public outreach and education opportunities to promote a variety of options consistent with regulatory guidance established as part of NYSDEC's Living Shoreline Techniques in the Marine District of New York State (2017). The New York Department of State (NYDOS) and NYSDEC are also developing a guide for residential coastal shoreline protection measures as part of NYDOS's Model Local Laws to Increase Resilience Guide (NYDOS 2019) that can be incorporated into local public outreach and guidance efforts by PEP.

WETLAND RESTORATION AND CREATION

Functioning wetlands provide natural flood protection and are another nature-based approach to coastal resiliency in the face of climate change. They filter out nutrients and toxic inputs, and they support species diversity. Restoration involves amending a wetland's physical, chemical, or biological characteristics to restore the ecosystem services it provides. PEP is completing a number of wetland restoration projects, including the Narrow River Road project in Southold, the Iron Point project in Southampton, and the Meetinghouse Creek Main Road project in Riverhead. These projects include maintenance plans to ensure their ongoing functioning.

FISHWAYS/DAM AND IMPOUNDMENT RESTORATION

Restoring and maintaining fish passageways for anadromous species to pass from saltwater to freshwater spawning grounds supports the species' ability to adjust their distribution and is an important way to help these species adapt to climate change. Barrier removal improves the natural flow of tributaries and reduces stagnation and related warming upstream. Barrier removal in coastal areas supports the landward migration of marshes. PEP is restoring access in several areas, including the Peconic River, Alewife Creek, Big and Little Reed ponds, and Stepping Stone Pond in Montauk.

Resilient Recreation

Designing parks and recreational facilities to store and filter stormwater will become necessary for flood control and to mitigate water quality impacts in the Peconic Estuary watershed. New York City's Department of Parks and Recreation has developed guidelines to incorporate resiliency planning into parks, beaches, marinas, playgrounds, wetlands and greenways, without compromising access or design. Many principles could be applied on the East End.

DESIGN AND PLANNING FOR FLOOD RESILIENCY: Guidelines for NYC Parks

https://www.nycgovparks.org/pagefiles/128/NYCP-Design-and-Planning-Flood-Zone__5b0f0f5da8144.pdf

PROMOTE STORMWATER INFILTRATION

The objective of actions such as bioretention, rain gardens, and swales, which promote stormwater infiltration, is to enhance the filtering and retention of nutrients, pathogens, and toxins in stormwater before it reaches groundwater and the Peconic Estuary. PEP is committed to promoting stormwater infiltration and has developed 12 subwatershed plans for the Peconic Estuary that identify cost effective strategies to help reduce stormwater runoff pollution and improve water quality. PEP and the East End municipalities have entered into an agreement to reduce stormwater runoff and pollution from septic system discharges, agricultural and residential fertilizer, groundwater flows, illegal dumping, floatable debris, and boat waste. The subwatershed plans recommend best management practices that are most effective for removing nitrogen and pathogens, such as bioretention and constructed wetlands. Although less effective, rain gardens and swales can be a cost effective option for small-scale retention projects. PEP is funding a cost benefit analysis of nitrogen reduction strategies that will consider climate change and will provide municipalities with another tool to prioritize and implement stormwater infiltration projects, especially as rain intensity is projected to increase. Maps created for this project will help PEP and municipalities identify areas where such strategies will be the most effective both today and in the future.

PROMOTE SEPTIC UPGRADES

Nitrogen load reduction is a priority issue for the water quality of the Peconic Estuary. Wastewater discharges from cesspools and individual septic systems are the largest source of nitrogen, and SLR has the potential to exacerbate the issue by decreasing the time groundwater takes to travel to the Estuary. As a result, PEP has committed significant time and resources to coordinating with Suffolk County, municipal agencies, New York State, USEPA, and the U.S. Geological Survey (USGS) to promote and implement cost effective septic upgrades. Suffolk County developed a Subwatershed Wastewater Plan (Suffolk County 2019) to identify priority watersheds for nitrogen reduction. It is also promoting residential Innovative and Alternative Onsite Wastewater Treatment Systems (I/A OWTS) by offering financial incentives through the Suffolk County Septic Improvement Program. The towns of East Hampton and Southampton require the use of I/A OWTS for new construction or substantial reconstruction town-wide (East Hampton) or in identified high priority areas (Southampton), and they are offering extensive rebate programs to incentivize I/A OWTS. The ability of septic upgrades to reduce the risks climate change poses to attaining PEP's management goals will be enhanced through the CLPS and CRA mapping by identifying areas where additional design considerations to address climate change impacts may be appropriate.

SEAWEED FARMING

Other than reducing CO2 in the atmosphere, options to reduce oceanic acidification are limited. Seaweed farming, however, has the potential to raise ocean pH locally through CO2 uptake and harvesting before the seaweed decomposes and releases its CO2 (Duarte 2017). Cultivating seaweed and bivalves together can maximize the benefit to these organisms. In 2017, Cornell Cooperative Extension conducted a Seaweed Aquaculture Feasibility Study in the Peconic Estuary to evaluate the ability of sugar kelp to sequester nitrogen and carbon from the water column while producing a renewable product. Although seaweed production was limited, the study yielded valuable data that may provide a starting point for larger scale operations. One such operation, at Widow's Hole Oyster Farm, has already harvested its first crop (Costanza 2018).

Strategies

The strategies described in this section support the adaptation actions described previously. Monitoring and assessment of pilot projects can help refine standards for siting and design. Including pilot projects in coordinated public education and outreach efforts can help publicize the risks of climate change and the benefits of living shorelines. Siting will also be an important factor in planning nature-based solutions. The updated CLPS analysis has helped identify parcels for future acquisition, buyout, and protection in developed and undeveloped areas predicted to be submerged due to SLR. Restoring these lands to their natural state can increase their quality and functionality and help preserve native biodiversity and connectivity—in addition to providing essential resiliency benefits. Nature-based approaches should be promoted through policy, regulations, and funding of pilot projects.

RESEARCH AND MONITORING

Research and monitoring will be a key component of adaptation strategies to ensure programs and projects are designed for—and can adapt to—changing environmental conditions. PEP is directing or assisting with several research and monitoring projects in the watershed. Many of these programs will help inform climate adaptation projects and can be expanded to include climate indicators as climate and related modeling—such as regional groundwater modeling being completed by USGS—become available. Current programs particularly relevant to climate change include the following.

Water Quality Monitoring Assessment Services: This program to monitor water quality in the Peconic Estuary has as one of its main goals identifying appropriate indicators of estuarine health that could be used to monitor climate change effects.

Hardened Shoreline GIS Mapping Project: PEP completed an inventory and mapping project to quantify the amount of hardened shoreline in the Peconic Estuary as part of the *Peconic Estuary Program Habitat Restoration Plan* (PEP 2017). This project builds upon a previous inventory from 2003. Results of the mapping can be incorporated into the CLPS process to further identify parcels that may be especially suitable for acquisition or preservation to prevent future hardening, to remove existing hardening, or to promote areas for habitat migration.

Eelgrass Bio-Optical Model: Because the Peconic Estuary has lost 80% of its eelgrass since 1930, PEP launched an eelgrass management plan in 2009 to prevent further losses, establish habitat for and increase eelgrass abundance, and advance understanding of eelgrass dynamics (PEP 2009). As part of its management plan, PEP is developing an eelgrass bio-optical model to gather site specific information for eelgrass management and restoration programs (PEP 2017b). This project will lead to a better understanding of specific light and temperature requirements for eelgrass in the Peconic Estuary. It is a critical next step toward recognizing not only the threats to the eelgrass community but also the locations where restoration projects

have the best probability of success. This modeling can help provide baseline data that can be used in future modeling to assess the effects of climate change on eelgrass habitat.

Fisheries Management: Fisheries management is a crucial part of assessing the changes in fish species diversity due to climate change and the early attempts to manage such risks. For example, New York State and Suffolk County have promoted shellfish aquaculture in the Peconic Bay to provide a sustainable fishery and achieve water quality goals. New York State ceded to Suffolk County title to approximately 100,000 acres of underwater land in Peconic and Gardiners bays for the purpose of shellfish cultivation and authorized the county to prepare, adopt, and implement a shellfish aquaculture lease program for this region. Suffolk County developed an Aquaculture Program Management Plan in 2009 to guide the growth of the industry and, with assistance from PEP, is conducting a 10 year review of the program to determine how it should be changed and implemented in 2020 and beyond. Because climate change, especially ocean acidification, has the potential to profoundly affect the health of this fishery, management goals must include monitoring of climate stressors. Singling out indicator species for climate stressors, such as shellfish for ocean acidification, will help track the effects of climate change separate from those of other stressors such as overfishing. PEP and NYSDEC are also funding an ecosystem modelling and vulnerability assessment project for the Peconic Estuary that will examine how fish species have altered their spatial distribution and habitat utilization in response to environmental changes and will identify which species are most vulnerable to these stressors.

LAND CONSERVATION AND ACQUISITION

Ensuring that wetlands and other coastal habitats have room to migrate inland is essential for the long-term health of the Peconic Estuary. Targeted land preservation and acquisition represents the most effective method to ensure key habitats are maintained in the face of climate change. This adaptation strategy also lends itself to partnering with other stakeholders, especially the Peconic Land Trust and towns and villages.

The updated CLPS analysis identified undeveloped parcels with the greatest potential to allow wetlands to migrate inland. Given the limited resources available for acquisition and the need to act quickly before land is developed, the updated CLPS program provides a strategic approach to land protection and priorities for future acquisitions. Changes in legislation or modifications to current land-use rules can help facilitate wetlands migration in places that cannot be protected through acquisition because they are too small, unsuitable, or otherwise unattainable. Minimizing future development and infrastructure investments in these areas will also reduce the risks to communities and property owners.

This report includes a Climate Adaptation Toolbox for Land Use and Municipal Planning that describes tools available to help local municipalities conserve and acquire land to promote climate resiliency.

OUTREACH AND EDUCATION

Public outreach and education will be a key part of climate adaptation planning because many of the strategies discussed previously will require strong public buy-in and support. As noted in

Section 1, public support for water quality and land protection is high in the region.

Engaging with the topic of climate change can be challenging. Current strategies to address the effects of climate change in the Peconic Estuary tend to highlight only the general effects of SLR and extreme storm surge on the built environment. Although early effects such as flooding during high tides are now evident, the more extreme effects are yet to arrive. Data from complex models can be hard to translate into meaningful impacts and actions. And the effects of climate change can be seen as so daunting that solutions seem out of reach.

One way to overcome some of these challenges is to make climate change science and adaptation strategies relevant to the public's everyday lives and greater social goals. Strategies that promote regular outreach, such as monthly columns in local newspapers, move climate change to the forefront of public discourse. Easy to understand visuals, such as the figures presented in Section 2, can also encourage conversation and action; general global issues such as SLR can be made local and residents can pinpoint actual homes, parks, and other community resources likely to be affected. These visuals can be shared easily and distributed through media channels.

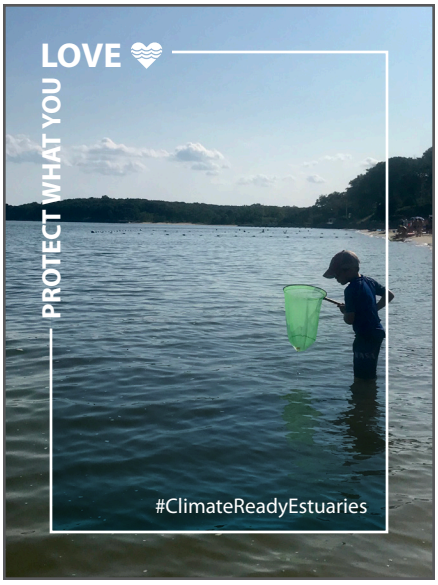
Curriculum that integrates climate change into existing educational goals and programs will encourage strategic thinking and provide students of all ages with the knowledge base to make informed decisions. PEP and stakeholder partners already work with local schools, and school curricula include units on local waterbodies and environments. Working within these existing programs, PEP could expand offerings to a variety of age groups. A targeted seminar on how climate modeling works might be geared to high school students interested in computer programing such as GIS as well as science and planning. The importance of wetlands could be incorporated into current elementary programs, especially the unit in which area second-grade students study and visit local water bodies.

In addition to outreach and education on the impacts of climate change and the application of adaptation actions to increase resilience to climate change, education programs on the importance of water conservation and water reuse are also encouraged. The NYSDEC Climate Smart Community (CSC) program provides funding and support for reducing greenhouse gas emissions and adapting to climate change. Some towns in the Peconic Estuary Program are CSC certified; additional municipalities should be encouraged to apply and public participation in these programs should be encouraged.

PRINT AND SOCIAL MEDIA CAMPAIGN

The Peconic Region has several well circulated news publications, including local weekly newspapers such as The Southampton Press, The East Hampton Star, Riverhead News Review, and Suffolk Times and monthly specialty publications such as Edible East End, Northforker, and the venerable Hamptons magazine. These publications have active websites and target residents and visitors; many of them have begun to highlight climate change. For example, the Suffolk Times hosted a panel discussion on Climate Change in the East End and followed with a multipage story in the following week's edition (Gannon 2019). Joyce Novak, Ph.D., of PEP spoke on the panel and was featured prominently in the print edition. And Long Island Wine Press magazine featured an article about the effects of climate change on the regions' wine industry. Opportunities to expand coverage include pursuing regular columns in newspapers and teaming with specialty publications to highlight issues affecting the Peconic Estuary in ways that are relevant to their readers. Edible East End highlights local food sources and harvesting and may be amenable to an article highlighting the potential for ocean acidification to affect the availability of local shellfish. Targeted press releases announcing the availability of this report and the updated CCMP could facilitate liaison between such publications and PEP.

Social media are another avenue to increase public conversation and disseminate information. As mentioned previously, the images produced through the CRA are shareable and can zoom in on specific areas to highlight localized effects. Another way to increase awareness through social media is to undertake campaigns that encourage public participation and sharing along a clear tagline. For example, Aspen Snowmass Mountain launched the "Give a Flake" campaign in 2018 to increase awareness of the impact of climate change on the ski industry.[5] Targeting skiers and snowboarders directly, the campaign highlighted the effects of rising temperatures on natural snow availability through messaging that tapped into the value of these resources to the individual—all through a catchy tagline. The campaign includes a website with a contemporary video and social media frames that emphasize social media sharing while also promoting individual actions. A similar "protect what you love" campaign could be developed for PEP emphasizing the valued resources of the Peconic Estuary, such as public beaches, access, recreational opportunities, and local food. An example of social media frame are presented.



5) Available at https://www.aspensnowmass.com/inside-aspen-snowmass/give-a-flake.

SCREENING ADAPTATION ACTIONS AND STRATEGIES

Each potential adaptation action and strategy category was screened to determine whether the action was appropriate based on its risk-reduction potential, feasibility, effectiveness, cost and cost effectiveness, ancillary costs and benefits, equity and fairness, and robustness. The results of this evaluation are indicated in the last column of Table 8. The potential actions and strategies deemed most feasible have the fewest barriers to implementation and are carried through and will be included in the revised CCMP.

As shown in Table 8, some of the adaptation actions were deemed not feasible and an adaptation action for some risks could not be identified. Although a goal of developing adaptation strategies is to be as comprehensive as possible, some risks may not be fully mitigated for various reasons, including capacity, cost, timing, lack of social or other consensus, and technological challenges. Using the Workbook as a guide, PEP staff identified such barriers to implementation. They also identified opportunities to overcome barriers and considered them in collaboration with stakeholders. For example, social barriers include a lack of public consensus on climate risks, a lack of awareness of environmental issues, and a lack of limits on the number of tourists visiting the region—plus the fact that the more extreme, future effects of climate change may be hard to grasp. The graphics developed during the CLPS process could overcome some of these barriers by providing clear and comprehensive pictures of risk. The adaptation planning process also helped identify new strategies, such as a social media campaign linked to tourism promotion to expand the reach of planning.

Table 8: Evaluation of Potential Adaptation Actions and Strategies

Risk Selected for Mitigation	Potential Adaptation Action	Could the action reduce likelihood*?	Could the action reduce consequence*?	Appropriate to Proceed with this Action?	Notes
SLR will flood/drown wetlands. If wetlands are not able to migrate landward, SLR rise could lead to wetland habitat loss.	Living Shorelines and Wetland Restoration/ Creation,	YES	YES	YES	Living shorelines and wetland creation/ restoration, along with upland land acquisition would provide more area for habitat migration .
	Land acquisition	YES	YES	YES	
SLR will increase the depth to eelgrass bed, decreasing sunlight penetration. Because sunlight is a limiting factor for eelgrass, SLR could lead to eelgrass loss.	Stormwater Management/Septic Upgrades	YES	YES	YES	Measures to improve water quality would help promote water clarity, which could promote sunlight penetration. Eelgrass management and restoration could help facilitate the migration of eelgrass to shallower areas.
	Eelgrass Management and Habitat Restoration	NO	YES	YES	
SLR may decrease species range by decreasing the area of beaches, wetlands, and tidal flats if those habitats are not able to mitigate.	Habitat Restoration/ Creation and Land Acquisition	YES	YES	YES	Habitat creation/restoration and upland land acquisition, would act provide more area for habitat migration.
SLR may affect some existing species management strategies (like impoundments, fish ladders).	Habitat Restoration Dam and Impoundment Removal	YES	YES	YES	Removal of built impediments may improve the ability of coastal habitats to adapt to SLR.
SLR may bring homes and other built infrastructure closer to Peconic Estuary waters and habitat, decreasing the area available for migration/ buffering.	Land Conservation and Acquisition	NO	YES	YES	Using maps developed for this project to identify appropriate areas, targeted land conservation and acquisition could help facilitate habitat migration.

Risk Selected for Mitigation	Potential Adaptation Action	Could the action reduce likelihood*?	Could the action reduce consequence*?	Appropriate to Proceed with this Action?	Notes
SLR may affect recreational access, infrastructure and resources (trails, beaches, parks) if habitat/coastal areas used for recreation (for example, beaches) are not allowed to migrate.	Land Conservation and Acquisition	NO	YES		Using maps developed for this project to identify appropriate areas, targeted land conservation and acquisition could facilitate habitat migration. Living Shorelines could help provide buffers to coastal recreational areas .
	Living Shore and Habitat Creation/ Restoration	NO	YES	YES	
More frequent and intense storms will increase erosion of shoreline habitat and eelgrass.	Living Shoreline, Habitat Creation/ Restoration and Land Acquisition	YES	YES	YES	Living Shorelines, habitat creation/ restoration, and upland land acquisition would provide more area for habitat buffering.
More frequent and intense storms may lead to more stormwater runoff into the Peconic Estuary, increasing non-point pollution and turbidity, and decreasing water clarity.	Promote Stormwater Infiltration and storage	YES	YES	YES	Measures that could help store and filter stormwater prior to discharge into the Estuary's waters and habitats will need to be more widespread and incorporated in a variety of areas including areas of built infrastructure, public parks, and agricultural lands to decrease inputs of unfiltered runoff and to facilitate freshwater recharge for periods of drought.
More frequent and intense storms may lead to more stormwater runoff into groundwater (water may bypass stormwater treatment/ flood sumps).	Promote Stormwater Infiltration	YES	NO	YES	Measures that could help store and filter stormwater prior to discharge into the Estuary's waters and habitats will need to be more widespread and incorporated in a variety of areas including areas of built infrastructure, public parks, and agricultural lands to decrease inputs of unfiltered runoff and to facilitate freshwater recharge for periods of drought,
More frequent and intense storms may lead to loss of built species management strategies	Living Shoreline	NO	YES	YES	Proper Siting, design, and construction of new living shorelines based on NYSDEC guidance (2017) and enhancement of existing ones could minimize the consequences of this risk.

Risk Selected for Mitigation	Potential Adaptation Action	Could the action reduce likelihood*?	Could the action reduce consequence*?	Appropriate to Proceed with this Action?	Notes
Warmer atmosphere and waters/changing seasons may accelerate species diversity/loss.	Population Surveys	NO	YES	YES	Although surveys are not an adaptation action, they can monitor species changes and inform future strategies.
Warmer atmosphere and waters/changing seasons may increase the numbers and levels of invasive species and may allow pests to survive winter adding pressure on native species.	Population Surveys	NO	YES	YES	Although surveys are not an adaptation action, they can monitor species changes and inform future strategies.
Warmer atmosphere/changing season may result in longer growing seasons, which may result in more inputs of chemicals and nutrients into estuary from lawns, golf courses and agriculture.	Promote Stormwater Infiltration	YES	YES	YES	Measures to help store and filter stormwater prior to discharge into the Estuary's waters and habitats will need to be more widespread and incorporated in a variety of areas including areas of built infrastructure, public parks, and agricultural lands to decrease unfiltered runoff and to facilitate freshwater recharge for periods of drought, Such measures should be tied with education and outreach to homeowners, businesses, and agriculture on the risks of and alternatives to fertilizers and pesticides.
	Reduced Use of Fertilizers and Pesticides				
Increased use of resources with longer warm weather season may lead to more recreational/commercial fishing conflicts and pressure.	Fisheries Surveys and Management	NO	YES	YES	Although surveys are not an adaptation action, they can monitor species changes and inform future strategies. New York's commercial fisheries are highly regulated to ensure baseline species levels are maintained. But as species levels change and recreational opportunities increase, commercial quotas may decrease. Monitoring key species will help inform recreational and commercial limits.
	Alternative Fisheries (seaweed farming)				
Warmer atmosphere and waters/changing season may result in species changes, which may affect recreational hunting and fishing.	Fisheries and Wildlife management	NO	NO	YES	Although surveys are not an adaptation action, they can monitor species changes and inform future strategies.

Risk Selected for Mitigation	Potential Adaptation Action	Could the action reduce likelihood*?	Could the action reduce consequence*?	Appropriate to Proceed with this Action?	Notes
Increased drought may decrease Peconic River and tributary flows and may limit freshwater input into creeks and the Peconic Bay.	Promote Water Conservation and Reuse	NO	YES	YES	Increased conservation and water reuse will help conserve freshwater resources in the region.
Increased droughts during growing seasons may affect species in upland watershed areas.	Promote Water Conservation and Reuse	NO	NO	YES	Increased conservation and water reuse will help conserve freshwater resources in the region.
Increased droughts may decrease recharge to groundwater table, while increasing pressure to pump.	Promote Water Conservation and Reuse	NO	YES	YES	Increased conservation and water reuse will help conserve freshwater resources in the region.
The rising groundwater table has the potential to bring inputs from septic/cesspools and non-point sources closer to Peconic Estuary. These increasing inputs may result in in more HABs.	Promote Septic Upgrades and Land Acquisition	NO	YES	YES	Promoting septic system upgrades will help reduce nutrient loading. Land acquisition will help buffer areas between infrastructure and habitats/groundwater.
Rising groundwater may increase the connections between saltwater and freshwater systems.	No Strategies identified	NO	NO	NO	Adaptation actions to mitigate or minimize saltwater intrusion will need to be studied for the region. Adaptation actions such as low-head dam for saltwater wedge may not work on a relatively narrow island, especially in the PEP region where Long Island's land mass forks thereby increasing the coastal boundary.
Increased acidification may affect the suitability of Peconic Bay for shellfish and fish and other species that also serve as habitat, which would affect species diversity and commercial and recreational fishing.	Seaweed Farming	NO	YES	YES	Seaweed farming has the potential to raise ocean pH locally through CO2 uptake and harvesting before the seaweed decomposes and releases its CO2 (Duarte 2017).

Risk Selected for Mitigation	Potential Adaptation Action	Could the action reduce likelihood*?	Could the action reduce consequence*?	Appropriate to Proceed with this Action?	Notes
Coastal acidification may affect shellfish viability, which will affect water quality.	Seaweed Farming	NO	YES	YES	Seaweed farming has the potential to raise ocean pH locally through CO2 uptake and harvesting before the seaweed decomposes and releases its CO2 (Duarte 2017). Cultivating seaweed and bivalves together can maximize the benefits to these organisms.

The final step in adaptation planning was to select strategies based on the screening process. Adaptation planning emphasized measures that would address multiple risks, support multiple goals, and built on existing strategies to address feasibility concerns. Table 9 presents the adaptation actions from Table 8 that were deemed appropriate to proceed with, other adaptation efforts by PEP and partner organizations that are underway in the Peconic Estuary, and an assessment of their ability to meet PEP's goals.

Table 9: Potential Adaptation Actions and Strategies

	1. Protect and Enhance Water Quality Protection	2. Maintain and Enhance Species Diversity	3. Protect and Restore Groundwater	4. Promote and Protect Recreational Opportunities	5. Protect and Promote Sustainable Fisheries	6. Protect and Promote Renewable/ Environmental Infrastructure	7. Protect Cultural Resources and Practices
Adaptation Action Projects							
Living Shorelines	●	●		●	●	●	●
Wetland Restoration	●	●		●	●	●	●
Riparian Habitat Restoration	●	●	●	●			
Dams and Impoundment Removal							
Promote stormwater infiltration	●		●			●	●
Upland Swales and Rain Gardens	●		●				
Bioretention	●		●				
Create deep pools (River)		●				●	
Promote Septic Upgrades	●		●	●	●	●	
Seaweed Farming	●	●					
Adaptation Strategies							
Research and Monitoring							
Water Quality Monitoring Assessment Services	●	●		●	●		
Hardened Shoreline GIS Mapping Project						●	●
Eelgrass Monitoring	●	●					
Fisheries Management							
Promote Water Conservation and Reuse		●	●				●
Land Conservation and Acquisition							
Climate-Based CLPS Criteria	●	●	●	●	●	●	●
Land Use Stakeholder Toolbox	●	●	●	●	●	●	●
Outreach and Education							
Climate Ambassador Program	●	●	●	●	●	●	●
Social Media Initiative	●	●	●	●	●	●	●
PEP Climate Curriculum (Living Lab Wetland)	●	●	●		●		
Media Outreach ("Climate Column")	●	●	●	●	●	●	●

INCORPORATING ADAPTATION ACTIONS AND STRATEGIES IN THE CCMP

Many of the adaptation actions and strategies discussed above will be incorporated into the new CCMP, which will serve as PEP's master planning document. PEP has already implemented some of these actions and strategies, such as living shorelines. Including climate change considerations and the results of this CRA in the updated CCMP will further support the expansion of such strategies and actions. Because PEP is a boundary organization, many of the adaptation actions and strategies presented in Table 8 are expected to be developed and implemented by partnering with stakeholders. For example, PEP's Climate Change Adaptation Toolbox for Land Use and Municipal Planning could be used to disseminate to stakeholders information and results from the CRA process. A separate guide to Land Use and Municipal Planning was developed to provide an overview of planning strategies (see next section). The GIS layers used to develop the climate based CLPS criteria and the CLPS ranking tool will also be made available for towns and other stakeholders to use in their own land preservation and acquisition programs (Appendix B).

FUNDING

Addressing climate change will take resources. Federal, state, and local resources are available, but they are often distributed through grants or other competitive solicitations that have tight deadlines and partnering requirements. Table 10 can be used by PEP, its partner organizations, and municipalities to identify key funding programs and begin to develop proposals before project solicitations are announced. The table should be periodically updated to reflect ongoing opportunities and track projects awarded in the region.

Table 10: Funding Opportunities

Resilient Communities Program

Applicable Adaptation Actions(s)	Funding Agency:	Proposal Timing:
• Living Shorelines • Wetland Restoration	National Fish and Wildlife Foundation (NFWF)	Anually, January

Website:

https://www.nfwf.org/ResilientCommunities/Pages/home.aspx

National Coastal Resilience Fund

Applicable Adaptation Actions(s)	Funding Agency:	Proposal Timing:
• Living Shorelines • Wetland Restoration	NFWF	Annually, Spring

Website:

https://www.nfwf.org/coastalresilience/Pages/home.aspx

Wetland Program Development Grants

Applicable Adaptation Actions(s)	Funding Agency:	Timing:
• Wetland Restoration	USEPA	Annually, Spring

Website:

https://www.epa.gov/wetlands/wetland-program-development-grants-and-epa-wetlands-grant-coordinators

North American Wetlands Conservation Act Grants

Applicable Adaptation Actions(s)	Funding Agency:	Timing:
• Land Acquisition and Conservation • Wetland Restoration • Habitat Restoration	USFWS	Annually, February

Website:

https://www.fws.gov/birds/grants/north-american-wetland-conservation-act.php

Atlantic Coastal Fish Habitat Partnership

Applicable Adaptation Actions(s)	Funding Agency:	Timing:
• Living Shorelines • Habitat Restoration • Create Deep Pools	ACFHP	Annually, August

Website:

http://www.atlanticfishhabitat.org/opportunities/funding/

Coastal and Marine Habitat Restoration Grants

Applicable Adaptation Actions(s)	Funding Agency:	Timing:
• Wetland Restoration • Habitat Restoration	NOAA	Annually, January

Website:

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

Climate Smart Communities

Applicable Adaptation Actions(s)	Funding Agency:	Timing:
• Promote Energy Conservation • Promote Water Conservation and Reuse • Living Shorelines • Wetland Restoration	NYSDEC	Annually, July

Website:

https://www.dec.ny.gov/energy/109181.html

Water Quality Improvement Project Program

Applicable Adaptation Actions(s)	Funding Agency:	Timing:
• Promote Stormwater Infiltration • Promote Septic Upgrades • Land Acquisition and Conservation	NYSDEC	Annually, Summer

Website:

http://www.dec.ny.gov/pubs/4774.html

SECTION 4:
CLIMATE ADAPTATION TOOLBOX FOR LAND USE AND MUNICIPAL PLANNING

As a boundary organization, PEP aims to make the information from the CRA Project widely available and useful to partner organizations, stakeholders, and the public. The GIS data layers, CLPS ranking analysis results, and risk analysis provide a powerful tool for local communities to visualize and identify areas that will be vulnerable to SLR and other climate change-related stressors. Towns and villages already use an assortment of tools to address wetland protection, flooding, and other land use concerns.

Entirely new methods to address the impacts of SLR and climate change need not be invented. Today's land use tools can be refashioned and applied to address climate change impacts. This section presents three toolboxes that have been developed to help promote and support climate-based adaptation and planning. The analysis in this report focuses on the ecosystem, but the ecosystem is not the sole consideration for a community preparing for and responding to climate change. The approaches used in the analysis can be coupled with assessments of the vulnerability of critical infrastructure and the social profile of a community to devise a comprehensive municipal climate

adaptation plan. The Land Use and Municipal Planning Toolbox is designed to help land use stakeholders bridge the ecosystem and community climate planning. It includes GIS layers, CLPS criteria, and other tools to help incorporate climate planning considerations in current and future land–use planning. Each town and village participating in PEP has an official comprehensive plan that provides overall goals and a vision for the future.[6] The comprehensive plan designates areas for future development and preservation and provides the legal basis for land-use regulations. The CLPS ranking and GIS layers give local governments the technical foundation to develop their coastal resilience comprehensive plans.

In addition to the guidance presented in this section, NYDOS released its Model Local Laws to Increase Resilience Guide in June 2019 which provides an overview of local land use laws and infrastructure specifications to help New York communities adapt to climate change. A full copy of the guide (NYDOS 2019) is available at

https://www.dos.ny.gov/opd/programs/resilience/Model_Local_Laws_to_Increase_Resilience.pdf. An indexed copy of the guide is available athttps://www.dos.ny.gov/opd/programs/resilience/index.html.

GIS Layers and CLPS Criteria

Climate change is expected to exacerbate the current threats to the natural communities of the Peconic Estuary. Rising seas threaten to drown tidal wetlands and eelgrass beds if they cannot migrate landward. In addition to protecting wetlands pathways, maintaining and increasing habitat restoration efforts to incorporate climate change impacts will be critical.

The updated CLPS program provides a strategic approach to land protection and priorities for future acquisitions. The CLPS GIS layers and the SLAMM model can be used to identify priority areas for establishing additional setbacks for wetlands and coastal features. Applying SLR science, a forward looking municipality could establish greater wetland setbacks and buffer zones for coastal features. Or, setbacks could be based on a projected shoreline position incorporating SLR and erosion rates over the life of a structure. Another approach would be to establish a tiered setback system, requiring deeper setbacks for larger structures and development projects.

6) Several East End communities also have adopted Local Waterfront Revitalization Plans (East Hampton Town, Village of Greenport, Village of Sag Harbor, and Southold Town), Hazard Mitigation Plans, Climate Smart Community Plans, or resource specific comprehensive plans that provide the basis for coastal resiliency planning and funding.

Zoning and Other Land Use Tools

The future of the wetlands and critical natural resources in the Peconic Estuary will depend on thousands of individual decisions made by local governments; state and federal agencies; private, public, and nonprofit landowners; and quasi-public agencies. But because municipal governments make the basic land-use decisions, the climate adaptation tools being offered focus on application at the local level. Towns and villages already use an assortment of tools to address land-use concerns such as zoning, wetland setbacks, and flood plain regulations. Municipalities may be able to make adapting to climate change simpler by refashioning and applying their existing powers in new ways.

The general categories of climate change adaptation approaches are the following: 1) Land preservation; 2) Accommodation; 3) Managed Retreat; and 4) Protection (hold the line).

Each approach can be achieved through a variety of planning tools. The lists of potential adaption tools provided here are neither comprehensive nor exhaustive. They are intended to give communities a few nature-based approaches and nonstructural measures consistent with the goals of PEP. Local examples are provided when available.

Climate Change Adaptation Approaches

LAND PRESERVATION
Preserves and enhances land at risk from SLR, land for natural resource and habitat values, surface water and groundwater quality protection.

ACCOMMODATION
Allows continued development of new structures but manages risks by conditioning development be built or retrofitted to be more resilient to SLR. Strategies include flood-proofing buildings, elevating buildings, roads and facilities; designing parks, plazas, ponds, garages, and public spaces to accept floodwaters; and improving flood-control structures.

MANAGED RETREAT
Discourages development and redevelopment in threatened areas and plans for the eventual removal or relocation inland of structures as they become threatened.

PROTECTION
Holds the line and keeps the water out within a specific range of SLR and storm surge. Prioritizes protection of critical infrastructure, but can have detrimental impacts to natural systems. Strategies typically include hard-engineered solutions (bulkheads, revetments, seawalls) and soft solutions (living shorelines, dune and beach nourishment).

INCORPORATE CLIMATE CHANGE IMPACTS INTO COMPREHENSIVE PLANS

Suggestions for consideration in Comprehensive Plan updates include the following:

- Identify climate change resilience and sustainability within the community's vision, mission, or goals
- Incorporate climate change projections into the scope and planning horizon of land-use plans and decisions. Adopt official New York State SLR projections
- Augment land preservation goals to include the following: high-valued underdeveloped lands that will allow for the inland migration of critical wetland habitats; developed and undeveloped lands projected to be submerged by rising sea levels; land overlying high groundwater resources expected to be affected by SLR
- Identify as the preferred strategy for enhancing resiliency the protection and restoration of natural defenses such as beaches, dunes, wetlands, natural vegetation, and soft solutions
- Site future public infrastructure outside vulnerable areas
- Identify areas that require special measures to protect them from the impacts of climate change
- Evaluate and identify additional land-use tools to reduce vulnerability to climate change risks
- Encourage green infrastructure and low-impact development to control stormwater runoff and limit flooding

INCORPORATE WETLAND MIGRATION AREAS AND SENSITIVE CRITICAL NATURAL AREAS INTO ZONING.

Sweeping changes to zoning districts may not be practical considering current development patterns and buildout in the communities of the Peconic Estuary. However, with the identification of areas vulnerable to SLR and climate change impacts provided by the CLPS analysis, municipalities could develop zoning regulations to improve coastal resiliency and protect targeted sensitive areas. Governments could classify vulnerable areas according to adaptation strategy (i.e., preservation, protection, accommodation, or retreat) and develop regulations for each zone. Zoning amendments can be for the following purposes:

- To reduce the density of potential new development and redevelopment
- To reduce the intensity and types of new development and redevelopment permitted to ensure compatibility with coastal processes
- To reduce the maximum size of structures so that fewer people and assets are at risk and structures can be moved more easily
- To reduce the maximum coverage of impermeable surfaces
- To increase minimum setbacks for natural protective features
- To prohibit shore-hardening structures

CREATE/AMEND OVERLAY DISTRICTS

Overlay districts allow municipalities to superimpose additional safeguards, standards, or incentives on an existing zone in areas with special characteristics. Many municipalities have adopted overlay districts to protect areas that have unique natural resources, including ground and drinking water resources, farmland, flood plains, Pine Barrens, and coastal areas. A shoreline or SLR overlay district could impose specific zoning regulations on land expected to be affected by climate change. To help safeguard natural protective features and improve coastal resiliency, overlay districts can require greater coastal setbacks for buildings or sanitary waste facilities; mandate vegetative buffers; restrict vegetative clearing; impose more stringent building regulations; prohibit the construction of new hard coastal structures; and regulate the replacement or reconstruction of existing hard armoring structures.

Local Example: East Hampton

To protect the town's natural shoreline and coastal resources, in 2007 East Hampton adopted a Coastal Erosion Hazard Overlay District that prohibits the construction of new hard coastal armoring in certain areas. The overlay district is divided into four coastal erosion zones each of which have similar features, characteristics, and storm exposures. The district establishes rules and standards for erosion control structures and projects that differ from one zone to the next.

Minimum fixed setbacks for wetlands and erosion-based setbacks for coastal features have been established throughout the Peconic Estuary, but SLR has not been considered. Minimum mandatory setbacks and regulations for nearshore, dune, beach, and bluff areas, referred to as the CEHA, have been established by New York State. In general, no new development is permitted in the mapped CEHA area. Tidal and freshwater wetlands, and their buffer areas, are also regulated by New York State. Municipal governments can replace the state as regulator for the CEHA and wetland areas as long as the local regulations are at least as protective as the state regulations, and many PEP partners have already done so.

INCREASE COASTAL SETBACKS

Buffer zones and setback standards in a zoning ordinance require landowners to leave undeveloped a portion of their property in order to protect important natural features and processes. There are several types of setbacks, including the following:

- Fixed mandatory setbacks measured from a specific, predetermined point (e.g., a wetland boundary)
- Erosion-based setbacks determined by a projected shoreline position based on rates of SLR and erosion
- Tiered setbacks that require smaller setbacks for smaller structures and larger setbacks for larger structures

SUBDIVISION AND OPEN SPACE DEVELOPMENT

Subdivision ordinances specify the conditions under which land can be subdivided into smaller parcels. Regulations govern lot layout, road design, stormwater runoff requirements, utilities (water supply, sanitary waste disposal, electricity, etc.) and minimum open space or park requirements. Open space, cluster, or conservation subdivision ordinances help maximize the amount of protected open space. Besides preserving important natural, cultural, or recreational resources, open space subdivisions provide more compact development away from sensitive resources. Municipalities could require that development in areas potentially inundated by rising sea levels be clustered in upland areas and that wetlands, wetland migration areas, floodplains, beaches, dunes, bluffs, and other sensitive coastal habitats be set aside in permanent reserves. To ensure that open space lands serve as flood buffers and protected habitat in perpetuity, conservation or rolling easements should be developed and recorded. Coupled with mandatory cluster provisions, subdivision regulations may need to be updated to provide clear methods to determine lot yield (i.e., eliminating underwater and undevelopable lands), increase coastal setbacks, prohibit subdivision of flood-prone lands, address increased stormwater cause by more intense storms, and require the use of low-impact and green development practices for building and stormwater control.

SITE PLAN CONTROLS/SPECIAL USE PERMITS

Site plan review enables municipalities to evaluate nonresidential and multifamily housing development and set reasonable conditions for approval. To increase coastal resiliency, site plan requirements can impose or strengthen standards that protect wetland pathways, wildlife habitat, coastal features, and natural vegetation. Drainage requirements can reduce the impacts of stormwater runoff. Along with, or in place of, structural drainage solutions, site plan standards can require conservation design strategies and the preservation of undisturbed areas and buffers to filter and control stormwater runoff. Reductions in clearing, grading, building coverage, and pavement coverage—along with locating development in less-sensitive areas—can improve resiliency and reduce runoff. Requirements can encourage the use of green infrastructure (see Green Infrastructure/ Stormwater Management).

VEGETATION PROTECTION ORDINANCE

Vegetation protection ordinances use zoning to restrict the amount of clearing permitted on a property. Natural vegetation protects shorelines from tidal energy, storm surge, and wave forces; stabilizes soil and landforms; filters pollutants from surface water runoff; preserves unique habitats and wildlife, and helps ensure high-quality groundwater recharge.

Ordinances can restrict the amount of clearing permitted on a lot or prohibit any clearing of vegetation in particular zones, such as beaches, dunes, wetlands, critical habitats, and their buffer areas.

Local Examples

East Hampton and Southampton have vegetation protection ordinances limiting the amount of clearing allowed in aquifer recharge areas. East Hampton also restricts clearing of lots within the Harbor Protection Overlay District (lots within a set distance from all harbors and bays) based on a sliding scale. Clearing in residential lots of less than 40,000 square feet is restricted to 10,000 square feet or 35% of the lot area, whichever is greater. Clearing in lots between 40,000 and 280,000 square feet is restricted to 10,000 square feet plus 12.5% of the lot area. The maximum clearing allowed in lots larger than 280,000 square feet is 45,000 square feet. Farmland and land that has already been cleared are exempt.

GREEN INFRASTRUCTURE/ STORMWATER MANAGEMENT REQUIREMENTS

Stormwater design criteria and best management practices may need refinement to account for changes from SLR, rising water tables, increasing storm frequency and intensity, and other conditions associated with climate change. By its very nature, green infrastructure is more adaptable to changing conditions than is grey infrastructure. Although green infrastructure is a proven, effective way to mitigate stormwater runoff, improve water quality, and increase coastal resiliency, it is less likely to be considered in development proposals unless the zoning code and regulations clearly state green infrastructure is acceptable or preferred. Green infrastructure practices include the following: filter strips, vegetated open swales, trees or tree boxes, rain gardens, green roofs, stormwater planters, rain tanks or cisterns, porous pavement, infiltration practices, wetland and floodplain preservation, open space design, and bioretention practices such as plantings in parking lots.

The CLPS database can help inform planning, site selection, practice selection, engineering design, and ongoing maintenance and operation to ensure the long-term effectiveness of a proposed stormwater improvement project. The following recommendations can ensure the long-term effectiveness of stormwater improvement projects in the face of climate change:

- Incorporate a 50-year or life-of-the-structure planning horizon
- Use SLR, flood maps, groundwater table, and other current databases to evaluate the best location for a project
- Select practices that will be effective under projected as well as current conditions
- Select materials appropriate to current and projected conditions
- Include redundant treatment or storage capacity
- Incorporate flexibility into designs
- Choose green over grey infrastructure
- Commit to undertake maintenance

CONSERVATION EASEMENTS

Conservation easements are flexible tools used in a variety of situations to protect land that has conservation value including working lands (farmland), natural resources, and sensitive environmental features, in whole or in part. Conservation easements are voluntary agreements between a private landowner and a governmental agency or qualified conservation organization to protect land of conservation value while allowing the land to remain in private ownership. Landowners who sell or donate a conservation easement may be eligible for a number of benefits including a charitable income tax deduction, a reduction in the value of their land for state and federal inheritance taxes, and lower property taxes. Thousands of acres of land in the Peconic Estuary, including farmland, woodland, wetland, and other sensitive coastal features, are protected by conservation easements held by Suffolk County, towns, and qualified conservation organizations like the Peconic Land Trust and The Nature Conservancy. Many publicly held easements have been acquired through town and county PDR programs on farmland. Some easements have been acquired by towns and villages during the development process as a condition for approving a subdivision or construction project.

Municipalities and conservation organizations can use the CLPS analysis to help identify priority areas for conservation easements to preserve land that could serve as a flood buffer, habitat, or migration corridor. Purchasing a conservation easement can be more cost effective than buying land outright. Additional tax incentives to landowners may also be considered to promote the donation of conservation easements.

ROLLING EASEMENTS

A rolling easement[7] is a conservation easement with a rolling boundary designed to preserve the ability of the shoreline to migrate inland. Rolling easements can allow property owners to build on their land in exchange for an agreement that no shore-hardening structure will be constructed. As the shoreline retreats, the easement boundary moves or "rolls" landward. By prohibiting hard coastal structures, rolling easements protect public access along the shore. The removal of structures may be required once they are seaward of the rolling design boundary or the structure becomes threatened by erosion. To facilitate the migration of wetlands, rolling easements may prohibit fill or elevation of the land. Rolling easements can be purchased or can be integrated into a regulatory framework. Compared to a setback regulation that could render an entire property undevelopable, a rolling easement may be a useful way to avoid or mitigate against a "takings" claim because it allows development and provides legal certainty about future requirements.

Although rolling easements are a relatively new, many states have enacted regulations calling for them in an effort to mitigate the effects of climate change and SLR. These states include Maine, Massachusetts, Rhode Island, South Carolina, California, and Texas.

6) A rolling easement "rolls" upland as sea level rise & coastal erosion cause coastline encroachment. In addition to prohibiting development, this can help facilitate the migration of CBPA buffers, dunes, living shorelines & wetlands, preserving their value for SLR adaptation, flood mitigation, and shoreline protection. For a comprehensive discussion on rolling easements see: water.epa.gov/type/oceb/cre/upload/rollingeasementsprimer.pdf. June 2011.

Riverhead, Southampton, and Brookhaven have adopted TDR ordinances to protect and maintain the Core Preservation Area of the Central Pine Barrens in accordance with the LI Pine Barrens Act; Southold, Southampton, Riverhead, and Brookhaven have TDR programs to help preserve farmland and other natural and cultural features; East Hampton has a wastewater credit TDR program to facilitate development of affordable housing.

TDR programs have not been used on Long Island to relocate existing development in high-risk coastal areas to areas outside the vulnerable zones. To facilitate the use of this tool to protect critical coastal properties, the LI Coastal TDR program is developing a voluntary framework that municipalities can adopt. A Generic Environmental Impact Statement will explore the ability to relocate development out of high-risk areas and assess the potential environmental impacts of redevelopment.

TRANSFER OF DEVELOPMENT RIGHTS PROGRAMS

TDR Programs enable the transfer of development from one parcel of land to another. As part of its zoning ordinance, a municipality establishes "sending districts" for the areas it desires to keep undeveloped or to become open space and "receiving districts" where higher density development could be accommodated. TDR programs invite landowners in a sending district to sell development rights from their land to a developer in a receiving district. The purchaser of the development rights is allowed to build at a density greater than ordinarily allowed by the base zoning of the receiving parcel. In exchange for this TDR, the sending parcel is permanently preserved and additional requirements such as the removal of structures and the restoration of the land to its natural state can be imposed.

Commercial centers in the Peconic Region may provide good opportunities for TDR programs to protect and restore valuable coastal resources while enhancing existing business areas. Unlike buyout programs, a TDR program does not eliminate current or potential commercial development (allowed by zoning) or take property off the tax rolls. Instead, TDRs redistribute development into a compact community design configuration. By keeping development compact, recreation and open space lands, shorelines, and critical natural habitats can be preserved and restored. At the same time, compact development promotes livability, walkability, transportation, energy efficiency, and business viability.

BUYOUT PROGRAMS FOR DEVELOPED LANDS

Rebuilding, restoring, and armoring the shoreline are common responses of homeowners to storm and flood damage. But for homeowners who no longer wish to live in high-risk flood zones, buyout programs provide the most effective strategy to eliminate risk while strengthening community resiliency and restoring natural coastal buffers.

Following Superstorm Sandy, Hurricane Irene, and Tropical Storm Lee, New York State's voluntary NY Rising Buyout and Acquisition Programs were established to purchase the properties of interested homeowners in areas that regularly place homes, residents, and first responders at risk. With its Buyout Program, the state purchases and demolishes the homes and maintains the land in perpetuity as open space and as natural coastal buffers. The state has partnered with local municipalities, including Southampton and Brookhaven, to establish long-term land stewardship and strategic green uses for the buyout areas. The transfer of 43 buyout properties to the Town of Brookhaven will be incorporated into the Mastic-Shirley Conservation Project, a wetlands restoration project managed by The Nature Conservancy. Funding for this program will soon expire, but other state and local CPFs and other acquisition programs can be used for buyouts. To optimize the use of limited public funds, the CLPS analysis provides a priority for the acquisition of developed land based on threat to the property from flooding and on habitat value, water quality protection value, and projected SLR.

PROHIBIT NEW SHORELINE STRUCTURES OR REPLACEMENT

Numerous state and local governments have outlawed or drastically reduced the construction of hard coastal structures through zoning and other legal mechanisms. Shoreline hardening structures prevent wetland migration and have been shown to have numerous adverse effects on natural resources including the following (NYSDEC Shoreline Stabilization PDF):

- Reduced or degraded habitat for breeding, spawning, nesting, feeding, growing, escaping from predators, and thermoregulation or "loafing" for a variety of fish and wildlife
- Impaired movement of organisms between aquatic and terrestrial habitats; altered physical structure of the water's edge, with resultant changes to hydrology
- Increased infestation of invasive plants due to wave action against the hard structure, causing increased fragmentation and dispersal of plants and "re-seeding" of the water body
- Local changes in water quality, including changes to temperature and increases in turbidity, nutrients, and contaminants
- Increased erosion of the adjacent natural shorelines and scouring in front of the structure

Although protecting critical infrastructure in coastal areas may be necessary, local governments can prohibit hard armoring structures along vulnerable coastlines with sensitive ecosystems and encourage living shorelines. Similarly, rebuilding shore-hardening structures can be restricted or prohibited.

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APPENDIX A:
STAKEHOLDER INVOLVEMENT

STAKEHOLDER MEETINGS

Kick-Off Meeting

January 29, 2018

This meeting was an introduction to CRA Project and process with primary project team members.

- Meeting Notes (includes attendees)

Stakeholder Workshop 1

September 21, 2018

This meeting introduced the larger CRA project and then held a workshop with participants to help develop new CLPS criteria.

- Meeting Notes
- Sign-In Sheet

Stakeholder Workshop 2

June 5, 2019

This meeting presented the results of the mapping and then held a workshop with participants to help identify and categorize risks.

- Meeting Notes
- Sign-In Sheet

Meeting Minutes

Peconic Estuary Program: Climate Ready Assessment Services
Kick-off Meeting

January 29, 2018
10:00 am to 12:00 pm
Cornell Cooperative Extension of Suffolk County, 1st Floor Conference Room
423 Griffing Avenue Riverhead, New York 11901

Attendees

Lisa Liquori	Fine Arts and Science	lis.liquori@gmail.com
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Chris Schubert	U.S. Geological Society	schubert@usgs.gov

Project Overview

This project is a result of a U.S. Environmental Protection Agency (USEPA) directive to perform a vulnerability assessment of the Peconic Estuary as part of the 2008 Climate Ready Estuaries Program. During development of the scope, USEPA approached the Peconic Estuary Program (PEP) to include a vulnerability assessment for the Shinnecock Indian Nation (“Shinnecock Nation” or “the Nation”) under this effort to take advantage of geographic overlaps and mutual goals. This kickoff meeting was identified as a first step in bringing the technical project team together and further defining the project scope and schedule.

Meeting Minutes

Introduction

Lena DeSantis of Anchor QEA opened the kick-off meeting and briefly presented an overview of the meeting structure and goals. Participants then introduced themselves and their roles.

- PEP: The project is being managed by PEP and overseen by Sarah Schaefer and Elizabeth Hornstein.
  - Climate Change Workgroup: The Climate Change Workgroup is a technical working group of PEP and will provide feedback throughout the process. The workgroup is co-chaired by Elizabeth Hornstein, PEP State Coordinator, and Alison Branco of The Nature Conservancy (TNC).
- Shinnecock Nation: The Shinnecock Nation was represented by Shavonne Smith, the Nation's Environmental Director. The Nation has a 12-person environmental department—many of whom will be involved in this project.
- Anchor QEA, The Nature Conservancy (TNC), and Fine Arts and Sciences: Anchor QEA is the prime consultant and will be supported by Lisa Liquori of Fine Arts and Science and TNC.

Climate Ready Assessment Services Overview and Approach: PPT Presentation

Lena gave a presentation on the overall scope of services, describing Task 1 as applicable to the PEP process of identifying climate change-based screening criteria and Task 2 as the vulnerability assessment that will address both the Peconic Estuary and the Shinnecock Nation. There will be overlap of the two tasks, but the tasks, as described in the RFP and proposal, are important to the contract and schedule.

- **Quality Assurance Project Plan (QAPP):** The QAPP is the first step of the process and must be approved by USEPA before technical work can begin. The draft QAPP has been submitted to USEPA for review. Sarah noted that a project manager at USEPA had been identified. PEP and Anchor QEA will respond to any USEPA concerns and keep the group up to date on its progress.
- **Task 1: Develop Climate Change Screening Criteria:** The PEP's Comprehensive Conservation and Management Plan (CCMP) is currently being updated to include climate change. Critical Lands Protection Strategy (CLPS) is a subset of the CCMP and identified and prioritized the land available for development in the Peconic Estuary, but it currently does not include climate change-based criteria to assess land protection. Task 1 will develop climate change screening criteria for the CLPS.

Some general criteria were presented and the consultant team will work with PEP and the Climate Change Workgroup to develop the initial list for stakeholder consideration.

- ***Action Item 1****: Consultant team to work with PEP and the Climate Change Workgroup to develop initial climate-based CLPS criteria to present for feedback at first stakeholder meeting.*

- **Task 1 and 2: Stakeholder Outreach:** Stakeholder outreach will happen throughout both Tasks 1 and 2 to solicit feedback on CLPS criteria and risks and vulnerabilities, and to present results. The group briefly discussed ways to increase outreach and participation (discussed further in the "Discussion" section).

- **Task 1: GIS Analysis:** Beth Lamoureux of Anchor QEA and Nicole Maher of TNC gave an overview of the spatial data that would be used in the GIS inundation mapping and analysis. The GIS analysis will map inundation related to climate change and wetland migration as predicated by the most up-to-date Sea Level Affecting Marshes Model (SLAMM) to identify parcels that meet one or more of the CLPS criteria.

  Glynis Berry of Peconic Green Growth noted that the Town of Southampton did a GIS-based analysis of the entire east end and asked if there would be overlaps. The effort is available on the Peconic Green Growth's website. The consultant team said they would look at the maps and contact the Town of Southampton to discuss. In general, there was consensus among the group to avoid redundancies.

  - ***Action Item 2:*** *Consultant team to look at available GIS data completed by the Town of Southampton as well as identify a list of spatial datasets that are not in-house or need updating. The consultant team will also identify relevant related work in the final reports.*

- **Task 2: Vulnerability/Risk Assessment:** Task 2 is the vulnerability and risk assessment for both PEP and the Shinnecock Nation. The vulnerability and risk assessment will proceed based on the USEPA's workbook (*Being Prepared for Climate Change, a Workbook for Developing Risk-based Adaptation Plans*), which will help focus the approach, especially considering the potential far-reaching implications of climate change.

- **Task 2: Present Results:** Under this subtask, risk assessment results will be presented to the technical teams and stakeholders for feedback. The consultant team will also identify solutions, emphasizing nature-based "green" solutions like preservation, restoration, and living shorelines, as opposed to hard engineering options like armoring. Due to the relatively short-term nature of the project, solutions will be presented in a "tool-box" fashion rather than defining specific projects.

- **Task 2: Finalize Report**: Under this subtask, the risk assessments will be finalized and reports will be submitted to PEP and the Shinnecock Nation.

Discussion

The presentation then moved to several slides that introduced topics for discussion.

- **Schedule:** The first item discussed was the schedule. Assuming the QAPP is approved within the timeframe identified (by end of February 2018), the final reports would be available by the end of February 2019. The group did not identify any issues with the schedule, and Sarah noted that the schedule overlaps with the CCMP update, so there may be opportunities to piggyback on the CCMP public meetings. It was also noted that while the initial stakeholder meetings would be focused on CLPS priorities, Shinnecock representatives would be encouraged to participate as many of the priorities would overlap with Shinnecock Nation goals.
- **Objectives/Priorities:** The group then discussed objectives and priorities with an initial focus on the Shinnecock Indian Nation, as PEP's goals are more dictated through the USEPA's Climate Ready Estuaries Program.

  Shavonne gave an overview of the Nation's concerns as well as a summary of their organization and efforts. The group clarified that the vulnerability assessment would cover all the Nation's lands, not just the Westwood property. Some of the Nation's top concerns include the following:

  - Hunting/Fisheries: The Nation uses the Westwood property to hunt and actively fishes in the waters surrounding all properties. Changing temperatures could lead to species changes. Potential climate impacts on flora and fauna is important to identify. Storms have the potential to effect water quality through runoff, which could prompt shellfish closures. There was concern regarding Heady Creek, where oysters are farmed. There is an ongoing project to test shellfish tissue, and results could inform the vulnerability assessment. While the Nation's land is not likely to be a major source of nitrogen loading to this watershed, contributions from adjoining lands may be contributing to water quality degradation.
  - Built Resources: The Nation has an active land use plan that has limited building on the shoreline, so most structures are not immediately at risk from sea level rise, but as a coastal community, and like most of the Peconic Estuary, flooding from extreme storms is a concern. In addition, several sacred sites, including a cemetery, are increasingly subject to flooding from rising sea levels and storm surges.
  - Water Quality: The Nation is actively engaging in measures to improve water quality through measures such as upgrading cesspools and storm drains, and there are several U.S. Geological Society (USGS) monitoring wells located on Nation properties. There is interest to address the long-term effect of climate change on water quality.

  - Saltwater Intrusion: Residential wells along the coastal areas have been tested for saltwater intrusion, which could increase with sea level rise. A significant stand of trees in the Point area are dying, most likely due to salt water intrusion or sea spray.

- The group then discussed several issues facing the region.
  - Glynis identified saltwater intrusion as criteria. Chris Schubert noted that the USGS has an ongoing effort to analyze how various factors, including climate change, may affect the long-term sustainability of Long Island's freshwater aquifer. The study is finding that saltwater intrusion has the potential to contaminate some wells but also may cause the water table to rise, which could lead to expansion of surface water bodies, shrinkage of the vadose zone leading to increasing runoff, and decreasing water quality.
  - The group discussed the role of zoning and permitting in habitat protection. For example, following storm events, the Towns often are presented with numerous applications to increase the size and scope of bulkheads. The group recognizes that municipalities may need to armor some resources, such as critical transportation corridors, but that soft-engineering strategies could further enhance such efforts and must be given equal consideration through the Towns' zoning codes and permit approval process.
    - The group also discussed the role of development rights and agriculture in climate change solutions, especially on the North Fork. The original CLPS study exempted agriculture. The climate assessment of risk to agricultural lands can be part of this evaluation.
  - There was some discussion about the limited scope of this project but that the stakeholder could provide an opportunity to identify climate changes risks that are not necessary within the PEP and the Shinnecock Nation's jurisdiction for use other efforts, such as Town plans.

- Integrate Efforts
  - The group discussed how this effort could be integrated with existing efforts. Alison brought up the point that the Towns formerly used the CLPS to identify projects under the Community Preservation Fund (CPF), and that through updating the CCMP and identifying more relevant CLPS priorities, this effort could again present a blueprint for CPF projects, especially because climate change overlaps with so many other regional land use goals, such as improving water quality, protecting habitat, and addressing erosion.

- Stakeholder Outreach and Participation
  - The group discussed ways to increase stakeholder participation and outreach. As previously mentioned, piggybacking on the CCMP process would provide one avenue. The

group also identified specific outreach to Town representatives, chambers of commerce, hatcheries, environmental and land use planning organizations, land trusts, civic associations, and farm groups, including wineries/breweries, and oyster farms. To get buy-in, relating climate change day-to-day issues was recommended. The group also discussed expanding the climate workgroup to include target representatives from the New York Department of Environmental Conservation, U.S. Fish and Wildlife Services, New York Department of State, and other agencies.

- ***Action Item 3****: PEP will work with the consultant team to identify overlaps with the CCMP process.*
- ***Action Item 4:*** *PEP will start to develop a list of current stakeholders with the consultant team's support.*

Next Steps

Four action items were identified:

- ***Action Item 1****: Consultant team to work with PEP to develop initial climate-based CLPS criteria to present for feedback at first stakeholder meeting.*
- ***Action Item 2:*** *Consultant team to look at available GIS data completed by the Town of Southampton as well as identify a list of spatial datasets that are not in-house or need updating. The consultant team will also identify relevant related work in the final reports.*
- ***Action Item 3****: PEP will work with the consultant team to identify overlaps with the CCMP process.*
- ***Action Item 4:*** *PEP will start to develop a list of current stakeholders with the consultant team's support.*

An announcement of the first public stakeholder meeting would be made after receiving feedback on the QAPP from USEPA.

Developing Climate Based Critical Lands Protection Strategy (CLPS) Screening Criteria

Peconic Estuary Program Climate Ready Assessment Services

Meeting Notes

September 21, 2018; 10:00 am

Suffolk County Community College Culinary Arts & Hospitality Center Room 211

- **Meeting Introduction**
  - Dr. Joyce Novak, Director, Peconic Estuary Program (PEP) welcomed and thanks attendees for their participation. Dr. Novak then gave an overview of the workshop goals and introduced the broader team.

- **Participant Introductions**
  - Participants introduced themselves in a roundtable fashion.
  - Attendees included: Suffolk County Legislator Al Krupski, Ross Slotnick from Legislator Bridget Fleming's Office, and representatives from New York State Department of Environmental Conservation (DEC), Peconic Land Trust, Peconic Green Growth, The Nature Conservancy (TNC), the Central Pine Barrens Commission, PEP and the Consultant Team (Anchor QEA, TNC and Fine Arts and Sciences)
  - Sign in sheet is attached.

- **Presentation**
  - Lena DeSantis of Anchor QEA presented:
    - An overview of the larger Climate Ready Assessment (CRA) Services project and the project schedule:
      - Project is to be completed within a year, and
      - Project includes several opportunities for stakeholder outreach.
    - The existing Critical Land Protection Strategy (CLPS) and the goals in developing new CLPS to address climate change.

- Meeting goal is to collaboratively develop new CLPS screening criteria and priorities that account for anticipated changing coastal conditions related to climate change.
- New criteria would not replace existing CLPS but add to them.
- Early thoughts on criteria goals include
    - Protecting sandy shorelines, both existing and migrating
    - Emphasis on protecting natural shorelines, especially any with multiple function habitats
    - Areas that would protect/buffer septic under sea-level rise.

- **Discuss Preliminary CLPS Reprioritization Criteria**
    - PEP began the conversations by asking the Towns how useful the criteria are for planning purposes.
        - Towns confirmed that they currently use the CLPS for land use planning, including on how to prioritize land purchases preservation strategies, and would like more guidance.
            - Some Towns use a rating system to identify strategies to help address different priority levels and opportunities, including prioritizing among:
                - Buildable vs Unbuildable, and
                - Developed vs Undeveloped.
            - Towns are actively considering all options including buy-outs to address loss due to climate change, having set criteria would assist in systematic approach.
            - Question from Southold Town on whether new CLPS should consider agricultural land.
            - Towns would like toolbox, including a GIS layer/layers, that they could directly use in-house for future planning.
    - The group discussed issues facing the area, with the main issues being:
        - Sea Level Rise: Mean changes and the increase effects from storms
        - Groundwater: Table rise and interactions with surface water, including saltwater intrusion
        - Hardened Shorelines: Both new and larger, higher, stronger rebuilds

        - Habitat loss, Ecosystem Changes

- The group discussed the current CLPS criteria, which can be found https://www.peconicestuary.org/wp-content/uploads/2017/05/CCMP_Chpt7.criticallandsprotection.pdf
    - There was a question about the definition of "Nitrogen Stressed Watershed" and discussion about how this would be updated based on new Suffolk County Sub-watershed Plan.
    - It was noted that there is a need to update the Critical Natural Resource Areas and that PEP may want to look at the NY State Significant Coastal Fish and Wildlife Habitats as well.
    - Although the National Wetland Inventory (NWI) maps are newer, the DEC 1974 Wetlands maps were accurate and identify some wetlands not mapped in NWI Maps.
    - The previous CLPS placed a higher priority on larger parcels, but the group felt small lots are important too; connectivity should continue to be a consideration.
    - The group then began to discuss development of the new criteria and how to develop criteria that could serve current needs but would also be dynamic enough to address future issues, especially as some data to inform decisions is not yet available (like USGS groundwater modeling data).
    - The group discussed how to use issues to develop CLPS and what issues could be addressed using climate based CLPS criteria, including
        - Regulatory issues involving zoning and variances are important conversations but the CLPS criteria may not be the appropriate or suitable tool to prevent undesirable small lot development,
        - NY Rising funding for rebuilding homes after storm damage does not include a requirement for septic upgrades. If there was a requirement for rebuilds to meet modern day septic requirements at the Suffolk County or municipal level, NY Rising would also require this improvement, and
        - Group requested information on model assumptions, especially in relation to elevation and land use.
    - The group identified some parameters that could be used to develop new criteria, including
        - Distance to groundwater (depth to water table)
        - Zoning lot size in relation to buffers
            - Identifying sub-parcels

    - Septic density
  - Intensity of use/recharge rates
  - Rate of shoreline loss
  - Wetland/marsh migration
  - Saltwater Intrusion
  - Natural habitat Protection (i.e. protecting existing natural beaches, wetlands, buffers etc.)
  - Flood/coastal hazards zones under climate change scenarios, Federal Emergency Management Agency (FEMA) 100-year flood plains, DEC Coastal Erosion Hazards Areas (CEHA)
  - Developed vs undeveloped

- **Next Steps**
  - Towns to provide PEP with GIS layers,
  - PEP team will develop new CLPS criteria based on attendee feedback.
  - CLPS Circulate for review, feedback
    - Due to schedule, only one round of review will be conducted,
  - PEP will generate final list and integrate into next steps of CRA.

Developing Climate Based Critical Lands Protection Strategy (CLPS) Screening Criteria

Peconic Estuary Program Climate Ready Assessment Services

Sign-In Sheet

September 21, 2018; 10:00 am

Suffolk County Community College Culinary Arts & Hospitality Center Room 211

Name	Organization	Email/Phone
Elizabeth Hartstein	PEP	
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Al Krupski	S.C. Leg.	852-3200
Colynis Berry	Peconic Greenbelt	info@peconicgreenbelt.org
Lauren Scheer	PEP	

DRAFT

Climate Based Critical Lands Protection Strategy (CLPS) Ranking Tool, Maps and Vulnerability Risk Assessment

Peconic Estuary Program Climate Ready Assessment Services

Meeting Notes

June 5, 2019; 1:00 pm

Suffolk County Community College Culinary Arts & Hospitality Center, Room 211

Meeting Goal: Collaboratively review new climate-based Critical Lands Protection Strategy (CLPS) ranking tool and maps that account for anticipated changing coastal conditions related to climate change, and provide feedback on vulnerability/risk assessment for the Peconic Estuary.

- **Meeting Introduction**
  - Dr. Joyce Novak, Director, Peconic Estuary Program (PEP) welcomed the group and introduced the project team, including PEP staff, Anchor QEA, the Nature Conservancy (TNC), and Fine Arts and Sciences.
  - Stakeholder participants then introduced themselves (see attached sign-in sheet)
  - Anchor QEA and TNC began a presentation focused on the CLPS Ranking Tool and Maps, and the Vulnerability/Risk Assessment for PEP.
    - The new CLPS criteria and ranking tool will be added to the Comprehensive Conservation Management Plan (CCMP).
    - The CLPS criteria and mapping will help inform the Vulnerability/Risk Assessment, which will be the basis of an adaptation report.
    - There is a parallel process ongoing for the Shinnecock Nation, but today's meeting is focused on the PEP.

- **CLPS Ranking Tool and Maps (see attached PowerPoint presentation)**
  - TNC and Anchor QEA presented the base maps and assumptions, the CLPS ranking tool and the resulting maps. Comments from the group included:
    - Southampton Councilman John Bouvier questioned if the mapping assumed any secondary affects from sea level rise (SLR) or other climate effects outside the PEP boundary. For example, did the team consider factors such as the creation of new inlets, which could connect systems not presently connected (for example, new connections between the Long Island Sound and the Peconic Bay).
      - PEP Consultant Team responded that such events were not considered in this analysis, as such information is not readily available, but could be part of possible climate assessments in the future.
    - Councilman Bouvier asked if critical upland infrastructure, such as substations or transportation networks, was considered in the mapping effort.

  - PEP Consultant Team responded that such critical infrastructure was generally not a PEP CCMP management issue. However, the GIS layers would be made available to the municipalities and other Land Use Stakeholders allowing them to overlay infrastructure and other critical resources. Stakeholders will decide how to apply the data and the tools.
- Chris Schubert of U.S. Geological Survey (USGS) questioned if geomorphological responses to storms and SLR were considered in the mapping and noted that the USGS's groundwater model should be available soon.
  - PEP Consultant Team responded that the new groundwater modeling results could be added when available. This effort is meant to be dynamic and will be updated periodically to include new data and climate projections.
- Several attendees including Suffolk County Legislator Al Krupski, Southold Town representatives and the Peconic Land Trust questioned why protected farmland was included in developed land category.
  - PEP Consultant Team responded that including farmland in the CLPS process was new and did not fit neatly in either box. While farmland may be protected from residential development, farm land is not included in the "Vacant, Recreation & Open Space" layer (Suffolk County Land Use 2016), which was the definition of the "undeveloped" category. However, we recognize that protected farmland is distinct from the general definition of "developed". The tool has been designed not only to help decide which lands to acquire, but to help decision makers evaluate which adaptation strategy is appropriate. For example, conservation easements governing protected farmland could be amended to not require active farming in areas mapped as being critical for marsh migration.
- An attendee asked how ranking is affected if a parcel is projected to convert to open water.
  - PEP Consultant Team responded that ranking would be the same as the tool is designed to be used to protect land now that may aid in future migration of marsh and other coastal habitats.

- **Vulnerability/Risk Assessment**
  - The group then began to review the Vulnerability/Risk Assessment and the PEP consultant team went over the way the assessment was completed. A separate Vulnerability/Risk Assessment was prepared for the Shinnecock Nation.
    - Risks were identified in prior stakeholder meetings
    - The risk assessment is specific to PEP and is based on PEP goals as largely defined by CCMP goals.
    - The analysis will be used to inform PEP priorities.
      - For example, a risk to upland transportation infrastructure, while critical to municipalities, may rank as a lower risk to PEP.

        - The tool can be used by the Land Use Stakeholders and modified to identify stakeholder specific vulnerabilities and risks.
    - As stakeholders to PEP, the Land Use Stakeholder Group was asked to provide feedback on the consequences, likelihood, spatial extent of impact, time horizon and other background assumptions used in the assessment.
    - Comments included:
        - Consider both the vertical and horizontal effects of rising groundwater
        - Along with detrimental effects from increased stormwater discharge, increased storminess may have beneficial to wetlands and other coastal habitats by moving sediment within the system.
        - USGS noted that their *Water Table Protective Model* includes a new surface water layer that should be available from CDM Smith.
        - Warmer waters may increase decomposition of peat in wetlands.
        - Consider snow levels and freezing/thawing separately as snow levels fluctuate normally in area but freeze/thaw events are changing as a result of climate change.
        - Consider the risk of a public desire to revert back to harden coastal structures (i.e. bulkheads and seawalls) as a high consequence of SLR in the "Renewable/Environmental Infrastructure" organizational goal.

- **Next Steps**
    - The PEP consultant team discussed the next steps for the project.
        - The project ends at then of July
        - Consultant team will prepare a report for PEP and the Shinnecock Nation which will include adaptation strategies based on work completed thus far.
            - CLPS ranking tools and maps will be finalized and provided as part of the adaptation strategy.

- **Meeting Close and Final Remarks**

Climate Based Critical Lands Protection Strategy (CLPS) Ranking Tool, Maps and Vulnerability Risk Assessment

Peconic Estuary Program Climate Ready Assessment Services

Meeting Sign-In

June 5, 2019; 1:00 pm

Suffolk County Community College Culinary Arts & Hospitality Center, Room 211

Name	Organization	Contact
Mike Lieberman	Town of Southampton	MLieberman@southamptontownny.gov
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~~Joyce Novak~~	PEP	
Sarah Schaefer		
Elizabeth Hornstein		

Climate Based Critical Lands Protection Strategy (CLPS) Ranking Tool, Maps and Vulnerability Risk Assessment

Peconic Estuary Program Climate Ready Assessment Services

Meeting Sign-In

June 5, 2019; 1:00 pm

Suffolk County Community College Culinary Arts & Hospitality Center, Room 211

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APPENDIX B:
CLPS GEODATABASE REVIEW AND DOCUMENTATION

September 2019
Peconic Estuary Program Climate Resiliency Assessment Services

ANCHOR QEA

CLPS Geodatabase Review and Documentation

Prepared for Peconic Estuary Program

September 2019
Peconic Estuary Program Climate Resiliency Assessment Services

CLPS Geodatabase Review and Documentation

Prepared for
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Riverhead County Center
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Prepared by
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Project Number: E71147-01.01
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ATTACHMENTS

1 Introduction

The goals of the analyses described in this report were the following: 1) to conduct a climate ready assessment (CRA) to incorporate climate change into an updated Critical Lands Protection Strategy (CLPS); 2) to conduct a risk-based climate change vulnerability assessment; and 3) to develop an adaptation action plan. The analyses relied on mapping of the data representing the CLPS criteria, as described in the CLPS Criteria Mapping Section of the main report. This document describes the quality assurance/quality control (QA/QC) review of the geospatial data used in the analyses, presents a complete set of maps for the individual data layers used in the CLPS criteria ranking, and includes a geodatabase of these layers along with the CLPS criteria ranking results.

2 Review of Spatial Data Used for CLPS Criteria Mapping

The GIS analysis was led by The Nature Conservancy, which acquired all the secondary data used in the analysis. All the geospatial input datasets, described in Table 2 of the main report and presented in Figures B-1 through B-2, were reviewed for completeness, accuracy, precision, representativeness, comparability, and sensitivity. Data were reviewed by Anchor QEA, LLC in accordance with the quality control checklist in the Quality Assurance Project Plan (QAPP) for this project (Anchor QEA 2017). The results of this evaluation, along with the use limitations of the individual data sets, are documented in Table B-1 of the project Quality Control Log (attached).

The data representing the CLPS criteria were used to rank parcels according to the scoring system described in the CLPS Ranking Tool section of the main report. This ranking was accomplished using ArcGIS geoprocessing tools, such as "spatial join" and "intersect," to overlay vector datasets to determine each parcel's attributes in relation to the proposed criteria. In addition, "zonal statistics" processes were used to summarize parcels by raster extent within them (e.g., marsh extent outputs from the SLAMM model). Points were assigned to each parcel based on the number of criteria it met, and the total score for the parcel was based on the sum of the number of achieved criteria using the scoring system described in the CLPS Mapping Section of the main report. Parcels were then ranked by the total number of environmental, climate, and other priority criteria met. The results of this ranking, presented in the Final Ranking Tool section of the main report, were reviewed for accuracy to ensure the parcels are within the Peconic Estuary watershed and the results make sense and are consistent with project objectives. The results of this evaluation, along with use limitations, are documented in Table B-2 of the Quality Control Log (attached).

3 Peconic Estuary CLPS and CRA Geodatabase

All spatial GIS layers used in this CRA are provided in the project base geodatabase (PEP_CRA_BaseData.gbd).

A second file project geodatabase (PEP_CRA_CLPS_Results.gbd) includes the results of the CLPS criteria ranking for parcels in the Peconic Estuary. These files are summarized in Table B-3.

4 References

Anchor QEA (Anchor QEA, LLC), 2017. *Quality Assurance Project Plan for the Peconic Estuary Climate Ready Assessment.* Prepared for the Peconic Estuary Program and U.S. Environmental Protection Agency. November 2017.

Tables

Table B-1
Quality Control Evaluation of Geospatial Input Data

Data Set	Source	Date	File Format	Filename	Figure	Metadata Available and Complete	Unit Consistency	Spatial Reference System	Grid Size and Tiling Consistency	NO DATA values in Raster Reviewed	Attribute Consistency
Suffolk County Tax Map Data	Suffolk County Real Property Tax Service Agency	2016	Shapefile	SCLANDUSEUSE2016_6TownMerge		No metadata provided; developed by TNC		WGS 84	NA	NA	Data were reviewed for correct topological structure.
SLAMM - Marsh Migration 2025	NYSERDA/Warren Pinnacle Consulting, Inc.	2015	Raster	SLAMM_Suff_2025_Medium.tif	B-2	Yes - Metadata files separate from rasters.	Meters	NAD_1983_UTM_Zone_18N	5,5	-99	NA
SLAMM - Marsh Migration 2055	NYSERDA/Warren Pinnacle Consulting, Inc.	2015	Raster	SLAMM_Suff_2055_HighMedium.tif	B-3	Yes - Metadata files separate from rasters.	Meters	NAD_1983_UTM_Zone_18N	5,5	-99	NA
SLAMM - Marsh Migration 2100	NYSERDA/Warren Pinnacle Consulting, Inc.	2015	Raster	SLAMM_Suff_2100_HighMedium.tif	B-4	Yes - Metadata files separate from rasters.	Meters	NAD_1983_UTM_Zone_18N	5,5	-99	NA
Significant Coastal Fish and Wildlife Habitats	NYS DOS	2015	Shapefile	Coastal_Habitats_ver2_NYSDOS	B-5	Yes	Meters	NAD_1983_UTM_Zone_18N	NA	NA	Data were reviewed for correct topological structure.
Digital Flood Insurance Rate Map Database, Suffolk County, New York	Federal Emergency Management Agency	2009	Shapefile	DFIRM Flood Hazard Areas (Suffolk)	B-6	Yes	Foot_US	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	NA	NA	Data were reviewed for correct topological structure.
SLAMM - Inundation 2025	NYSERDA/Warren Pinnacle Consulting, Inc.	2015	Raster	SLAMM_Suff_2025_Medium_Inundation.tif	B-7	Yes - Metadata files separate from rasters.	Meters	NAD_1983_UTM_Zone_18N	5,5	-99	NA
SLAMM - Inundation 2055	NYSERDA/Warren Pinnacle Consulting, Inc.	2015	Raster	SLAMM_Suff_2055_HighMedium_Inundation.tif	B-8	Yes - Metadata files separate from rasters.	Meters	NAD_1983_UTM_Zone_18N	5,5	-99	NA
SLAMM - Inundation 2100	NYSERDA/Warren Pinnacle Consulting, Inc.	2015	Raster	SLAMM_Suff_2100_HighMedium_Inundation.tif	B-9	Yes - Metadata files separate from rasters.	Meters	NAD_1983_UTM_Zone_18N	5,5	-99	NA
Groundwater travel time to surface waters	Suffolk County / CDM Smith	2016	Shapefile	Groundwater_TravelTime_Task2A_Revised_03162018	B-10	No metadata provided; developed by TNC	Foot_US	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	NA	NA	NA
Current depth to groundwater	USGS	2016	Raster	DepthToGroundwater_USGS_2016	B-11	Yes	Foot_US	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	32.8084, 32.8084	Yes (3.40282346639E+38)	NA
Depth to groundwater after 34" SLR	Suffolk County / CDM Smith	2016	Shapefile	DepthToGroundwater_Comp_34in_SLR	B-11	No metadata provided; developed by TNC	Foot_US	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	NA	NA	Data were reviewed for correct topological structure.
Critical Environmental Areas (CEA) in NYS	NYS Department of Environmental Conservation	2016	Shapefile	Critical_Env_Areas_SPGAs_only	B-12	Yes	Meters	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	NA	NA	Data were reviewed for correct topological structure.
Farmland parcels with development rights purchased from County/Town.	Suffolk County	2016	Shapefile	FarmlandPDR_SC_08_13_19		No metadata provided; developed by TNC	Foot_US	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	NA	NA	Data were reviewed for correct topological structure.
Farmland parcels with development rights purchased from Town.	Suffolk County	2016	Shapefile	FarmlandPDR_SC_03_03_15		No metadata provided; developed by TNC	Foot_US	NAD_1983_StatePlane_New_York_Long_Island_FIPS_3104_Feet	NA	NA	Data were reviewed for correct topological structure.

Notes:
1. No data values indicates the numeric value applied to areas in a raster dataset where there is an absence of data.
2. Tiling consistency, or cell alignment, applies to overlapping rasters and was confirmed by reveiwing the spatial extent values of each overlapping raster.

Table B-2
Verification and Validation of CLPS Ranking and CRA Results

Data Set	Source	Date	File Format	Filename	Data Fall Within Peconic Estuary Watershed?	Data Consistent with Project Objectives	Use Limitations
All Parcels intersecting the Peconic Estuary boundary	The Nature Conservancy	2019	Feature Class	PEP_CRA_Parcel_Summary_Merged	Yes	Yes	Tax parcel information subject to Suffolk County use limitations.
Undeveloped Parcels	The Nature Conservancy	2019	Feature Class	Undeveloped_PEP_CRA_Parcel_Criteria_Ranking	Yes	Yes	Tax parcel information subject to Suffolk County use limitations.
Developed Parcels	The Nature Conservancy	2019	Feature Class	Developed_PEP_CRA_Parcel_Criteria_Ranking	Yes	Yes	Tax parcel information subject to Suffolk County use limitations.
Agricultural Parcels	The Nature Conservancy	2019	Feature Class	Agricultural_PEP_CRA_Parcel_Criteria_Ranking	Yes	Yes	Tax parcel information subject to Suffolk County use limitations.

Notes:
CRA: Climate Ready Assessment
CLPS: Critical Lands Protection Strategy

Table B-3
Summary of CLPS and CRA Geodatabase Files

Filename	File Type	Description
PEP_CRA_BaseData.gbd		
SCLANDUSEUSE2016_6TownMerge	Feature Class	Suffolk County Land Use: land use categories used to characterize parcels as developed, undeveloped, or agricultural.
SLAMM_Suff (multiple_layers)	Raster Datasets	SLAMM model prediction for marsh migration potential or be inundated under selected sea level rise scenarios.
FEMA_fld_zone_dissolve	Feature Class	Federal Emergency Management Agency mapping of the present-day 100-year floodplain in the Peconic Estuary.
Coastal_Habitats_ver2_NYSDOS	Feature Class	Significant Coastal Fish and Wildlife Habitats in the Peconic Estuary.
DepthtoGroundwater_USGS_2016	Raster Dataset	Current elevation of the groundwater tabel from USGS 2016.
DepthtoGroundwater_Comp_34in_SLR	Raster Dataset	Depth to groundwater predicted after 34-inch sea level rise by CDM Smith as part of the Subwatershed Prioritization Project for Suffolk County (2016).
Groundwater_TravelTime_Task2A_Revised_03162018	Feature Class	Groundwater travel time to surface waters estimated by CDM Smith as part of the Subwatershed Prioritization Project for Suffolk County (2016).
Critical_Env_Areas_SPGAs_only	Feature Class	Special groundwater protection area identified by the New York State Department of Environmental Conservation.
FarmlandPDR_SC_08_13_19	Feature Class	Farmland parcels that have purchased development rights on them from the County or County/Town.
FarmlandPDR_SC_03_03_15	Feature Class	Farmland parcels that have purchased development rights on them from the Towns.
PEP_CRA_CLPS_Results.gbd		
Undeveloped_intersecting_PEP_CRA_Parcel_Criteria_Ranking	Feature Class	CLPS criteria ranking for Undeveloped parcels in the Peconic Estuary watershed.
Developed_intersecting_PEP_CRA_Parcel_Criteria_Ranking	Feature Class	CLPS criteria ranking for Developed parcels in the Peconic Estuary watershed.
PEP_CRA_Parcel_Summary_Merged	Feature Class	All parcels (developed, undeveloped, agricultural, and underwater land) intersecting the Peconic Estuary summarized by criteria and ranking scores where applicable.

Notes:
CRA: Climate Ready Assessment
CLPS: Critical Lands Protection Strategy
USGS: United States Geological Survey

Attachment

Peconic Estuary Climate Ready Assessment

Present Tidal and Fresh Marsh Extent

SLAMM Habitat Category*

- Fresh Marsh/Swamp
- Tidal Marsh

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM deterministic model

0 2.5 5 10 Miles

N

The Nature Conservancy

*SLAMM categories are crosswalked from National Wetlands Inventory

Peconic Estuary Climate Ready Assessment

Future Tidal and Fresh Marsh Extent: 2025 Medium Scenario (6" SLR)

SLAMM Habitat Category*

- Fresh Marsh/Swamp
- Tidal Marsh

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM deterministic model

0 2.5 5 10 Miles

N

The Nature Conservancy

*SLAMM categories are crosswalked from National Wetlands Inventory

Peconic Estuary Climate Ready Assessment

Future Tidal and Fresh Marsh Extent: 2055 High Medium Scenario (21" SLR)

SLAMM Habitat Category*

- Fresh Marsh/Swamp
- Tidal Marsh

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM deterministic model

0 2.5 5 10 Miles

N

The Nature Conservancy

*SLAMM categories are crosswalked from National Wetlands Inventory

Peconic Estuary Climate Ready Assessment

Future Tidal and Fresh Marsh Extent: 2100 High Medium Scenario (47" SLR)

SLAMM Habitat Category*

- Fresh Marsh/Swamp
- Tidal Marsh

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM deterministic model

0 2.5 5 10 Miles

N

The Nature Conservancy

*SLAMM categories are crosswalked from National Wetlands Inventory

Peconic Estuary Climate Ready Assessment

Significant Coastal Fish and Wildlife Habitats (SCFWH)

Significant Coastal Fish and Wildlife Habitats

Data source:
NYS DOS 2015

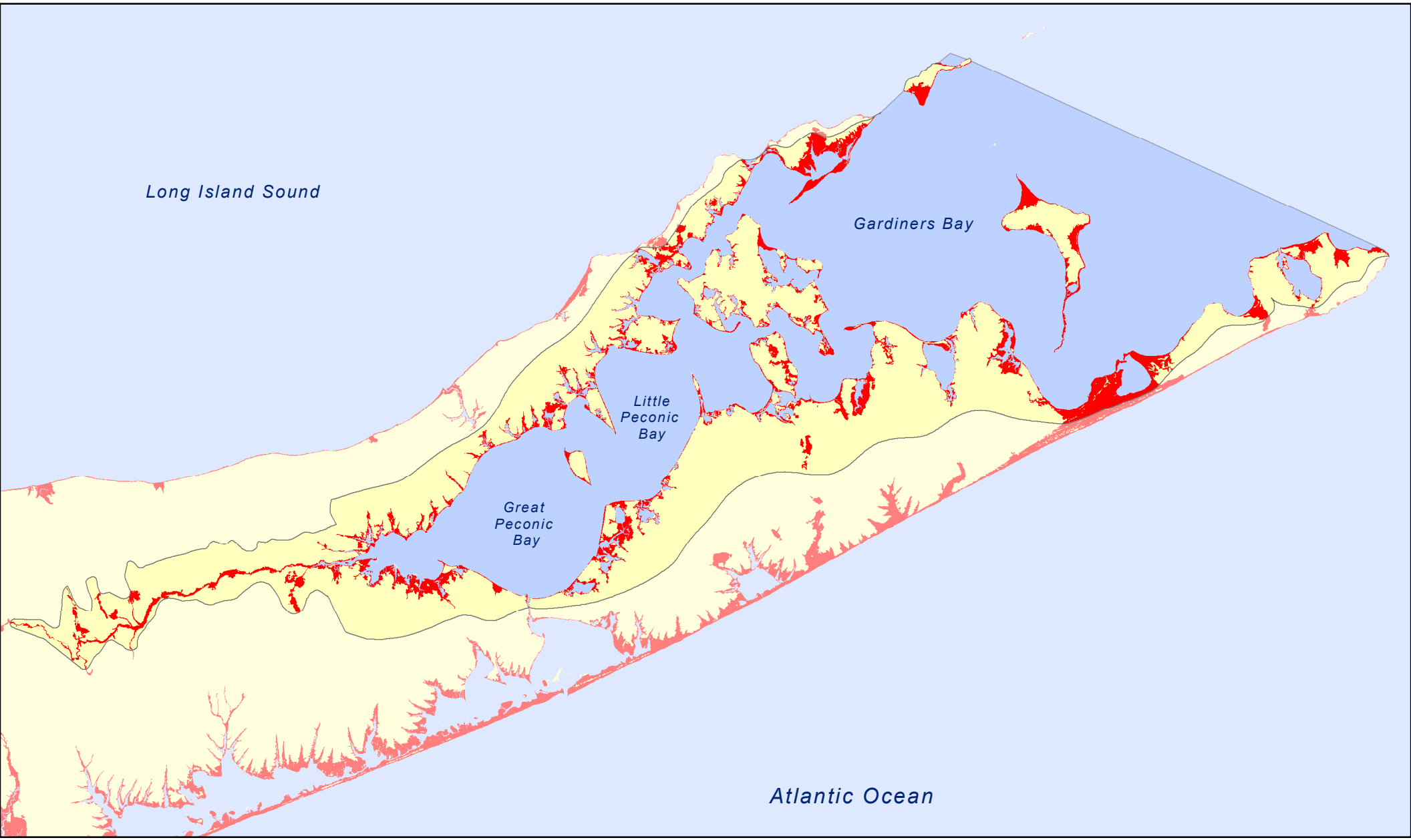
0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

FEMA 100-year Floodplain



FEMA Flood Hazard Area

100 yr floodplain*

*A, AE, V, VE zones

Data sources:
FEMA 2009 Flood Hazard Areas

0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

Inundation 2025 Medium Scenario (6" Sea Level Rise)

Medium 2025 Scenario - 6" SLR

Future Inundation*

*flooded at least once every 30 days

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM inundation frequency

0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

Inundation 2055 High Medium Scenario (21" Sea Level Rise)

High Medium 2055 Scenario - 21" SLR

Future Inundation*

*flooded at least once every 30 days

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM inundation frequency

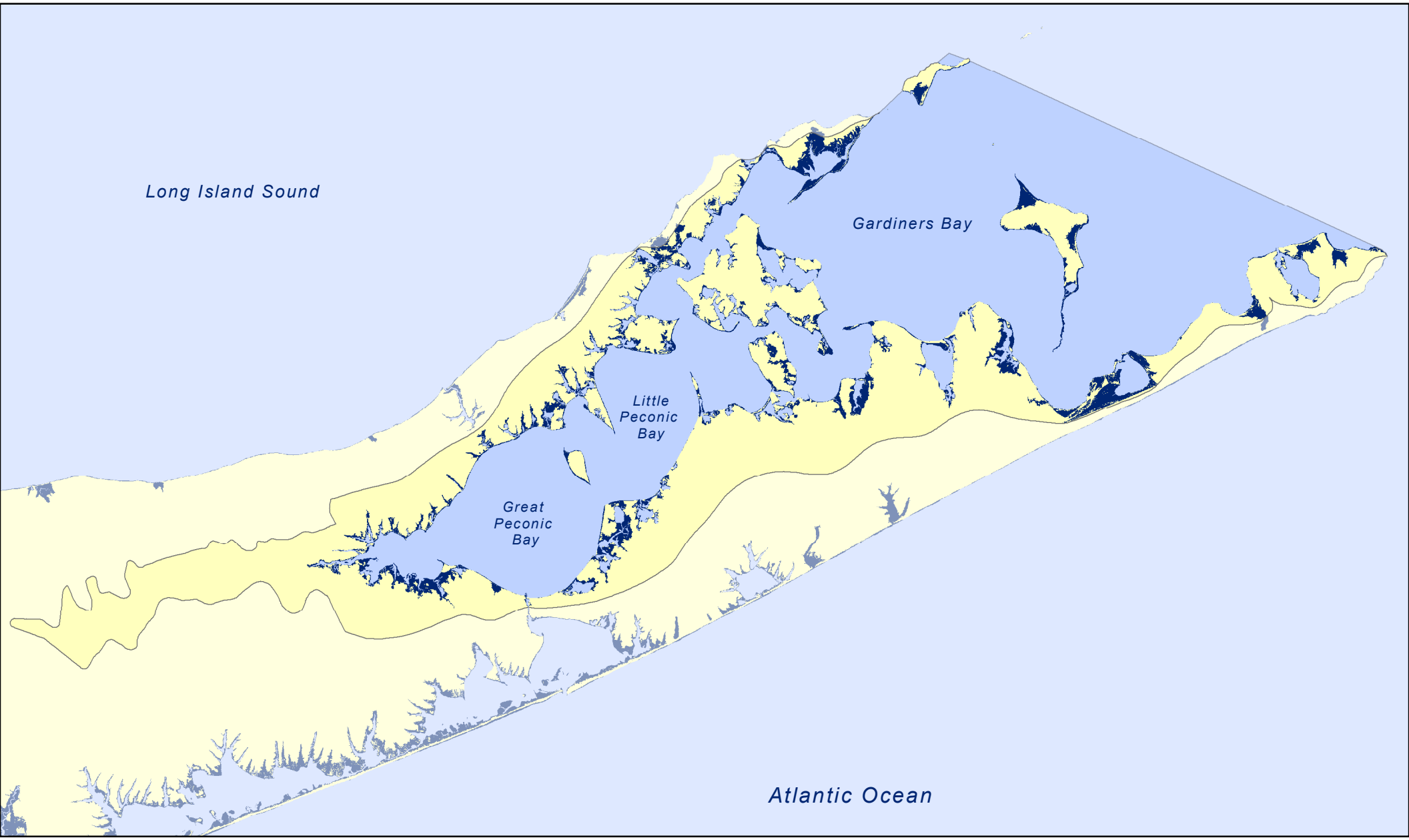
0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

Inundation 2100 High Medium Scenario (47" Sea Level Rise)



High Medium 2100 Scenario - 47" SLR

Future Inundation*

*flooded at least once every 30 days

Data sources:
NYSERDA/Warren Pinnacle 2015
SLAMM inundation frequency

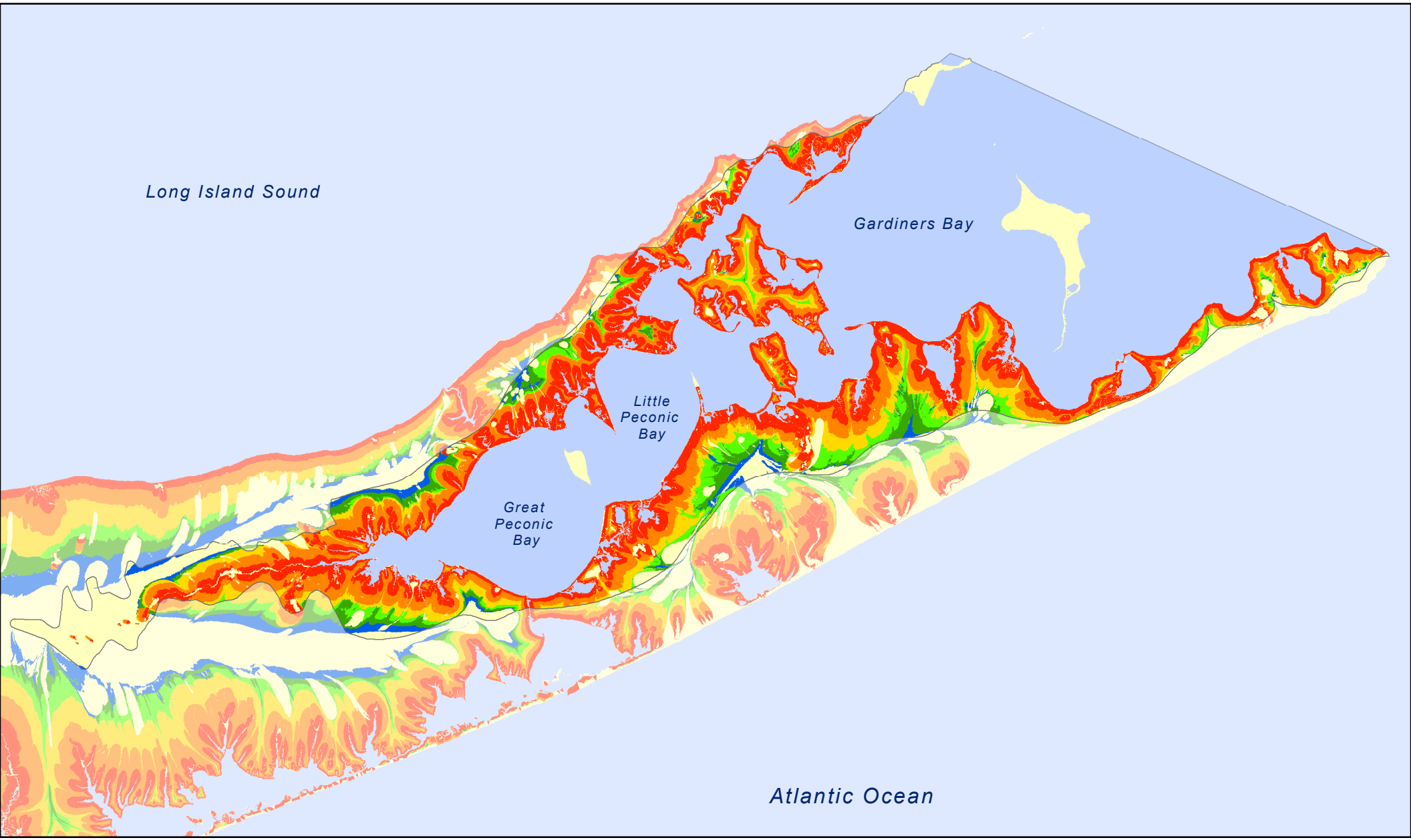
0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

Groundwater Travel Time to Surface Waters



Groundwater travel time to surface waters

- 2 years
- 10 years
- 25 years
- 50 years
- 100 years
- 200 years

Data sources:
Suffolk Co./CDM Smith
Groundwater Travel Time

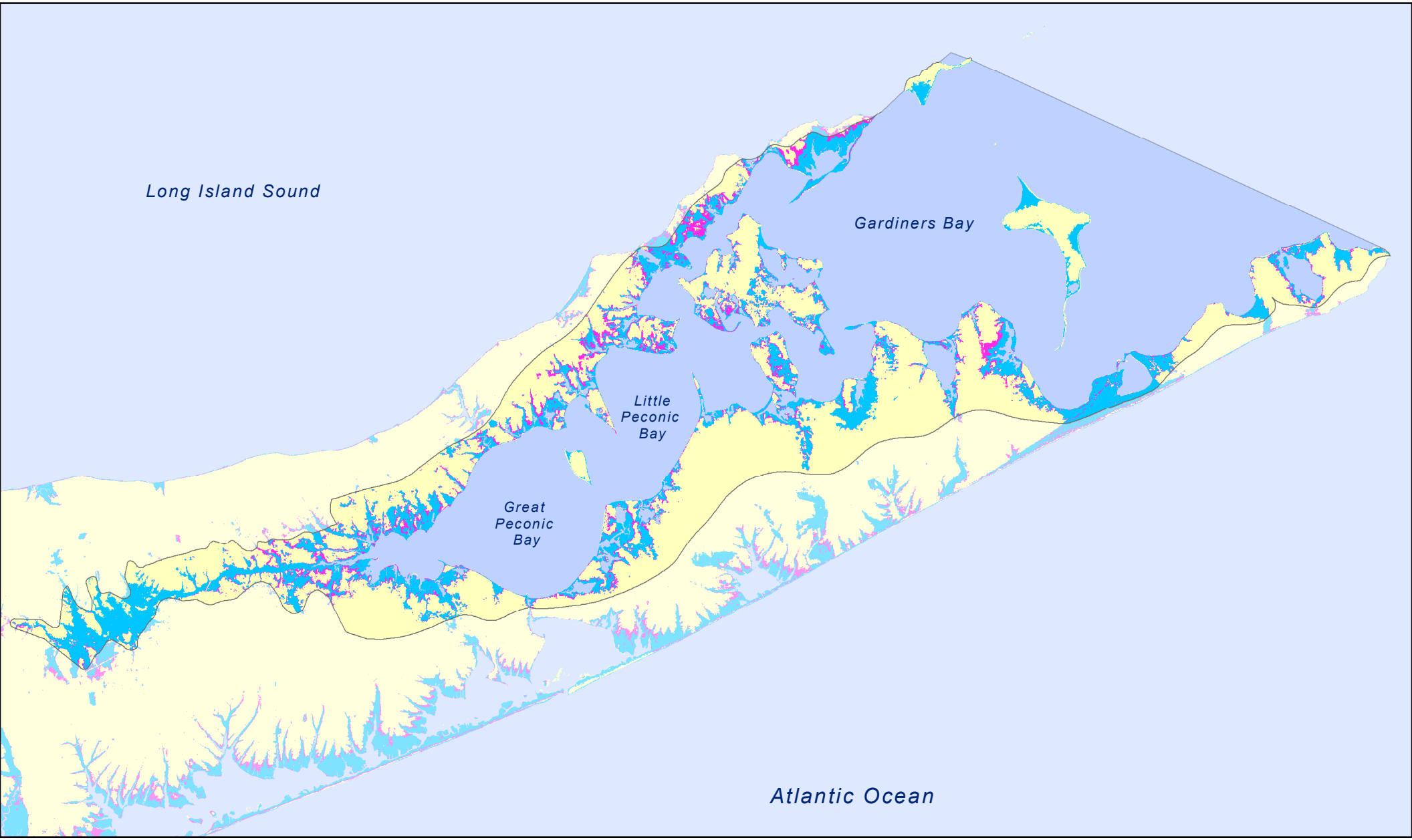
0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

Shallow Depth to Groundwater (10 feet or less)



Depth to Groundwater

- 10 feet or less - 2016
- 10 feet or less - after 34" sea level rise

Data sources:
USGS Depth to Groundwater 2016
Suffolk Co./CDM Smith
Rising groundwater table

0 2.5 5 10 Miles

N

The Nature Conservancy

Peconic Estuary Climate Ready Assessment

Special Groundwater Protection Areas (SGPAs)

Special Groundwater Protections Areas (SGPAs)

Data source:
NYS DEC 2016
Critical Environmental Areas

0 2.5 5 10 Miles

N

The Nature Conservancy