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Shinnecock Indian Nation Climate Vulnerability Assessment and Action Plan

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Peconic Estuary Climate Vulnerability Assessment and Action Plan

Prepared for

Peconic Estuary Program
Riverhead County Center
300 Center Drive, Room 204N
Riverhead, New York 11901

Shinnecock Indian Nation
100 Church Street
Southampton, New York 11968

Prepared by

Anchor QEA, LLC
123 Tice Avenue, Suite 205
Woodcliff Lake, New Jersey 07677

The Nature Conservancy
250 Lawrence Hill Road
Cold Spring Harbor, New York 11724

Fine Arts and Sciences LLC
PO Box 398
East Hampton, New York 11937

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Shinnecock Indian Nation Council of Trustees

Lance Gumbs, Dondi Williams Jr., Linda Franklin

Shinnecock Indian Nation Environmental Management Department

Shavonne Smith, Viola Cause, Steven Smith, Fordel Willis

Peconic Estuary Program

Joyce Novak PhD, Director; Sarah Schaefer, Program Coordinator; Elizabeth Hornstein, State Coordinator; Lauren Scheer, Education and Outreach Coordinator; Adelle Molina, Education and Outreach Assistant, Peconic Estuary Program; Jenna Schwerzmann, Education and Outreach Assistant; Kaitlin Morris, Education and Outreach Assistant

U.S. Environmental Protection Agency, Region 2

Sheri Jewhurst, Aisha Sexton-Sims, Javier Laureno, Noemi Mercado

Key Partners and Contributors

United States Geological Survey (USGS) New York Water Science Center, New York State Department of Environmental Conservation (NYSDEC) Region 1, New York Department of State (NYDOS) South Shore Estuary Reserve, New York Sea Grant, Peconic Land Trust, Central Pine Barrens Commission, The Nature Conservancy, Cornell Cooperative Extension of Suffolk County, Peconic Green Growth, Peconic Estuary Protection Committee, Accabonac Protection Committee, Suffolk County Department of Health Services, Christopher Gobler PhD, Byron Young

ABBREVIATIONS

CO_2	carbon dioxide
CRA	climate ready assessment
CRRA	Community Risk and Resiliency Act
GIS	Geographic Information System
HAB	harmful algal bloom
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
PEP	Peconic Estuary Program
SLR	sea level rise
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*

1 Introduction

The Shinnecock Indian Nation (Shinnecock or Nation) Reservation is located on the South Fork of Eastern Long Island. The Nation was recognized by the federal government on October 1, 2010. Its territory consists of 800 acres of ancestral land adjacent to Southampton, referred to as "the Neck," which supports homes, community facilities, and businesses, and "Westwoods," a pristine woodland in Hampton Bays that serves as a tribal gathering place for spiritual and recreational purposes (Shinnecock Indian Nation 2013).

Eastern Long Island faces numerous pressures, including development, habitat loss, and water quality degradation primarily as a result of nutrient loading. The Shinnecock Nation has identified climate change as a factor of concern. Among the challenges climate change poses are sea level rise (SLR), more frequent and more intense storms, and changing weather patterns—and the human responses to them. All have the potential to further to degrade water and habitat quality and lead to greater habitat loss and fragmentation.

The Nation's lands are particularly vulnerable to SLR and to major storms and associated flooding. The Neck is a low-lying, south-facing peninsula in Shinnecock Bay, and Westwoods includes beach and bluffs bordering Peconic Bay (Figure 1). Climate-change-related water quality issues, such as higher temperature, salinity, and acidification, are also potential threats to the Nation's lands and lifestyle. The Nation is closely tied to the marine and coastal environment; fish and shellfish have been a staple of the Shinnecock diet for thousands of years (Shinnecock Indian Nation 2013). Several native coastal plant species, such as sassafras (*Sassafras albidum*), are used in cultural practices (Viola Cause, personal communication, January 29, 2019).

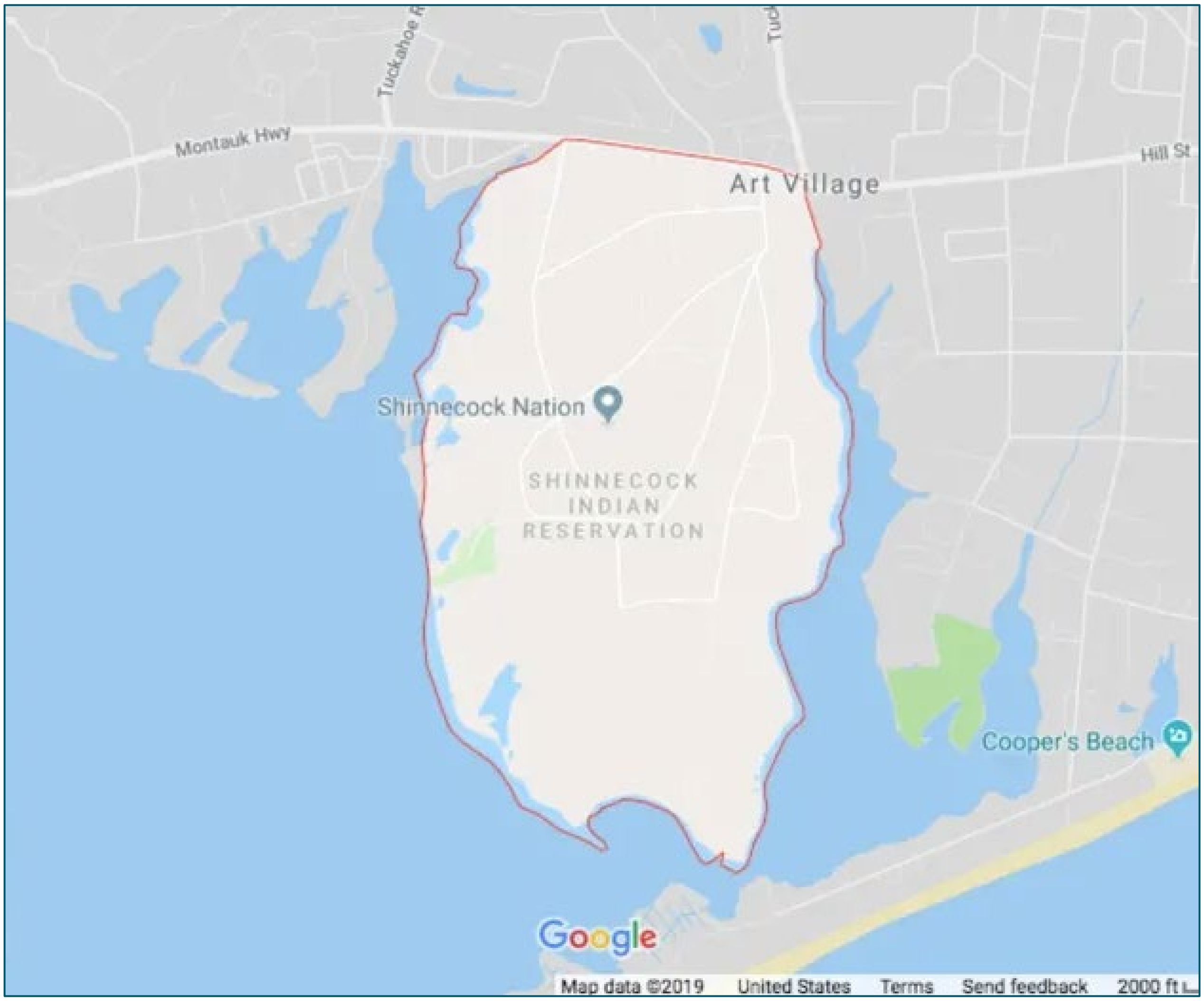
In 2013, in response to the effects of Hurricane Sandy, the Shinnecocks completed a Climate Change Adaptation Plan to begin to address the risks associated with climate change. As more climate-related information and planning tools have become available, the Nation, in partnership with the Peconic Estuary Program (PEP) and the U.S. Environmental Protection Agency (USEPA) Climate Ready Estuaries program, sought to conduct a risk-based climate change assessment to build on the 2013 report and document vulnerabilities. Using USEPA's Climate Workbook as a guide, this report documents the approach, methods, and results of the Nation's Climate Risk Assessment (CRA) and presents a climate ready action plan based on the assessment's results.

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

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, the Nation's effort to address climate change will be a continuous process.

Figure 1
Shinnecock Indian Nation



Source: TK

1.1 The Shinnecock Indian Nation

The Shinnecock are an Algonquian-speaking people descended from the Pequot and Narragansett Nations of southern New England. "Shinnecock" means "people of the stony shore"; their ancestral lands were on the southeastern edge of Long Island, along Peconic and Shinnecock Bays. Historically, the Shinnecock were seafarers and farmers. During the spring and summer, they lived closer to the water; in the fall and winter, they lived in the woodland areas. The Shinnecocks were known for their wampum, beads made from the Northern quahog clam and whelk (Stone 1983).

Today, the tribe lives primarily on the Neck and is self-governing. The Neck supports 600 to 700 residents and 150 homes. Community structures on the Neck include a preschool, health center, administration building, church, powwow fairgrounds, tribal building, museum, warehouse, cemeteries, five docks, and a fish hatchery. There are nine private businesses, most located along Montauk Highway (Shavonne Smith, personal communication, January 29, 2019).

Tribal lands and waters and the natural resources they support remain highly valued by tribal members, who harvest food and shells from their lands and adjacent waters. Cultural ceremonies are practiced both at the Neck and at Westwoods. The annual Labor Day Powwow is one of the largest gatherings of Native People on the East Coast and is celebrating its 72nd year in 2019.

Climate change, especially sea level rise, has been identified by the Tribe as a risk to residential and community structures, facilities, and utilities on the Neck (Shinnecock Indian Nation 2013). In the short term, climate change will stress existing infrastructure and will pose a risk to residential structures closest to the water. In the long-term, sea level rise could shrink the extent of the Nation's land, and some homes and properties may be lost. The southern portion of the Neck already experiences routine flooding, which will likely become more pronounced as sea level rises (ref). The bluffs along the beach at Westwoods have also severely eroded (Shinnecock Indian Nation 2013).

Shinnecock Indian Nation members are particularly concerned with the loss of land through erosion and sea level rise because options to replace sovereign lands may be limited if a broad-scale managed retreat is necessary. Consequently, the Tribe is actively pursuing sustainable adaptation planning and projects. For example, in 2013, the Shinnecock released a Climate Adaptation Plan which identified key community risks and early adaptation actions. The risk of land loss figured prominently in the plan. As part of adaptation planning, through a partnership with Cornell Cooperative Extension and Suffolk County, the Shinnecock implemented a seven-component coastal habitat restoration project to restore 3,000 feet of shoreline to Shinnecock Bay; add acres of habitat for marine life such as oysters, crabs, fluke, and flounder; and halt the erosion of the land in that area (Shinnecock Nation 2019).

1.2 Regional Environment

1.2.1 Shinnecock Bay

Shinnecock Bay lies between the South Fork of Long Island and barrier islands to the south. The bay includes open water, salt marshes, and intertidal flats. It is connected to the Atlantic Ocean through Shinnecock Inlet, to Moriches Bay by the Quogue Canal, and to Peconic Bay through the Shinnecock Canal. Shinnecock Bay provides significant habitat for fish and shellfish, migrating and wintering waterfowl, colonial nesting water birds, beach-nesting birds, migratory shorebirds, raptors, and rare plants (NYDOS 2008).

1.2.2 Peconic Bay

Peconic Bay is part of the Peconic Estuary and lies between the North and South Forks of eastern Long Island in New York's Suffolk County. The Peconic watershed comprises 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, 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. Peconic Bay is a relatively shallow system made up of many bays and creeks, with deeper open water zones. Fresh water from the Peconic River and brackish water from numerous creeks result in salinity levels lower in the bay than in the adjacent Long Island Sound and Atlantic Ocean (PEP 2019).

1.2.3 Regional Land Uses

The region's predominant land uses are residential (suburban), recreational (tourism), and agricultural. The Shinnecock and Peconic bays are used extensively for recreational boating, swimming, and fishing. Peconic Bay also supports commercial fisheries including bay scallop, weakfish, winter flounder, and a growing shellfish aquaculture program (PEP 2015).

1.2.4 Climate Change and Eastern Long Island

Conservative projections for the Long Island region include air temperature increases from 3°F to 6.6°F by 2050, greater temperature variability, increased seasonality, and more frequent extreme temperature events. Ocean temperatures in the area are expected to rise between 4°F and 8°F over the next century. And although area rainfall will likely increase in both quantity and intensity—with an increase in total rainfall of 1% to 13% expected by 2050—periods of drought are also expected to increase (Horton et al. 2014).

SLR poses one of the most immediate risks to the region. It threatens residential and commercial infrastructure and investments, transportation infrastructure, habitat, access to recreation and recreational facilities, and drinking water (largely due to saltwater intrusion). The region is also experiencing more "sunny day" flooding when high tides reach levels normally seen only as a result of coastal storms or king tides.[1] 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 New York State Community Risk and Resiliency Act (CRRA) established SLR projections for the region based on the 2014 ClimAID update (Horton et al. 2014). The CRRA projections have been adopted at the state level (6 NYCRR Part 490, Projected Sea-level Rise). Table 1 shows the CRRA projections for the Long Island region.

[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.

Table 1
CRRA Sea Level Rise Projections for the Long Island Region (in inches)

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.

Data collected from tide gauges at Montauk, where SLR of almost 4 inches has been measured since 2000 (NOAA 2019), appear to be tracking the medium scenario.

Because they can absorb storm energy (Costanza et al. 2008), wetlands are increasingly seen as a first line of defense against storm surge, which adds to their value in land preservation. Although wetlands can migrate inshore with rising waters (Langley et al. 2009), several factors including shoreline type and property development can affect their movement. Narrow coastal areas can block nearshore migration pathways (Kirwan et al. 2010). Without a sufficient supply of sediment, low marsh wetlands can drown if blocked pathways prevent their landward migration as sea level rises.

The great variety of habitats in the watershed support diverse plant and animal species and populations, but climate change will threaten species in numerous ways, including the following:

- Warmer temperatures will promote increases in non-native pests. SLR will increase saltwater intrusion into the aquifer, 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 shells or skeletons (Talmage and Gobler 2010).
- Climate change will affect the occurrence, types, abundance, distribution, and duration of harmful algal blooms (HABs) in bay waters (Griffith and Gobler 2019).

Groundwater is the primary source of drinking water for the region’s communities and of freshwater for the region’s rivers, ponds, wetlands, and bays. 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 water quality (PEP 2007; Lloyd 2014). The most serious threat to the water quality in the region is nitrogen pollution, which is the main cause of hypoxia and HABs and a contributing factor in the loss of critical eelgrass (*Zostera marina*) and wetland habitats (PEP 2007). Groundwater pumping has led to 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 rainstorms—will likely lead to increased land-based and atmospheric inputs of nutrients (Sinha et al. 2017; USEPA 2019).
- 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 2016).
- 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 region's freshwater-fed habitats (USGS 2019).

2 Vulnerability Assessment and Climate Action Plan

The Shinnecock Nation's vulnerability assessment and climate 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 standardized process for identifying, analyzing, and comparing risks associated with climate change and for making plans to adapt to climate change—all based on USEPA's experience with watershed management. The Workbook also includes an interactive online companion tool that guides users through the steps of creating a vulnerability assessment.

The vulnerability assessment was conducted by PEP in close consultation with the Shinnecock Environmental Department and the Natural Resource Committee. The Shinnecock Environmental Department developed the goals of the vulnerability assessment within the context of the Shinnecock Vision Statement by reaching out to members of the tribe to identify specific climate-based stressors and risks. To determine vulnerability, risks were ranked by their expected effect on the Nation's ability to meet its 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 various forms, and it 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.

2.1 Context for Assessment

The first step in conducting a vulnerability assessment related to a subject as far-reaching as climate change is to set the context for analysis, which establishes the assessment's scope and boundaries. The context for this analysis is the Vision Statement for Shinnecock Quality of Life (Shinnecock Indian Nation 2013):

- Teach and promote spirituality, respect, responsibility, integrity, and unity in order to promote and ensure the health, well-being, and safety of individuals, community, and the Nation
- Preserve and promote our sovereignty and freedom of self-determination in order to advance the common good of the people and Nation
- Restore, maintain, and foster our Shinnecock Culture, values, traditions, and human rights
- Conserve, manage, and utilize our tribal lands, natural and cultural resources in a sustainably appropriate manner while balancing our economic growth and community needs
- In all economic development, the Shinnecock Nation will seek to ensure that such opportunities are culturally sensitive and protect and preserve the soundness of our environment

Working within this context, the staff of the Shinnecock Environmental Department identified specific goals against which climate risks could be assessed. These goals and their relationship to the Nation are presented in Table 2.

Table 2
Shinnecock Indian Nation Climate Vulnerability Goals

Goal	Details
Protect Transportation Network	SLR and storm flooding were identified as risks to the Nation's roadway infrastructure. Some roads are already susceptible to flooding during high tides and storms. Increased flooding will require transportation network upgrades (culverts, storm drains, raising roads).
Protect Cultural Resources	Climate change has the potential to change species' ranges and to flood ancestral lands. The Nation's identity is strongly tied to ancestral practices, many of which are associated with the specific flora and fauna found on ancestral land and in the Peconic and Shinnecock Bays. For example, the Nation extensively uses plants in cultural practices. Huckleberry, sassafras, and pine needles, all found in Westwoods, are used for food, tea, and medicine and in ceremonies. Pitch pine resin is used in the construction of tools. Many tribal members rely on traditional food sources, and members fish and hunt (primarily deer) at both Westwoods and the Neck. Traditional fisheries include crabs and shellfish. The Nation also uses ancestral land for recreation and for ceremonies.
Protect Natural Resources and Water Quality	Because of the strong ancestral connection to the land and water, as well as a commitment to promoting environmental goals to protect human health, the Nation values its natural resources. Climate change is viewed as a threat to aquatic water quality and habitat, especially traditional fisheries such as shellfish, and to the health of the soil, groundwater, and plants.
Protect Human Health	The Nation sees climate change as a direct and indirect threat to its members' health. Direct threats include episodes of extreme heat. Indirect threats include reduced emergency access during storms.

2.2 Climate Stressors and Risks

The next step in the vulnerability assessment process is to identify climate stressors, which are a broad category of climate change factors such as SLR and more frequent and intense storms, and to consider their localized effects in a watershed. The Workbook lists six climate stressors to consider (USEPA 2014). The Shinnecock Nation adopted the Workbook list and added a seventh stressor, rising groundwater, as follows:

- **SLR:** This stressor considers the effects of higher water levels at the shoreline and the effect SLR may have on groundwater in the Nation's lands. The National Oceanic and Atmospheric Administration's (NOAA's) Sea Level Rise Viewer was used to map SLR at the Neck.
- **Warmer Waters:** This stressor considers the effects of higher water temperatures on the chemical, physical, and biological characteristics of adjacent coastal waterbodies, including Shinnecock Bay and Peconic Bay. Ocean temperatures in the region are expected to rise between 4°F and 8°F over the next century. Because the bays 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 change periodically apart 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, higher precipitation rates, and more total precipitation during storms. It also considers the effects of more extreme storms such as nor'easters and hurricanes, secondary effects 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 also 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 impact of higher levels of carbon dioxide in the atmosphere that dissolves into surface waters, affecting oceanic pH by creating carbonic acid. Over the past 300 million years, the oceans have been slightly basic, averaging a pH of approximately 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 region's marine resources is an active area of study. Recent research predicts the collapse of the bay scallop population by 2100 based on expected increases in atmospheric CO_2 levels and the resulting increased acidity of the water column (Grear et al. [forthcoming]).
- **Rising Groundwater:** This climate stressor considers the effect of rising groundwater on the Nation's lands. Groundwater levels are expected to rise as a result of increased precipitation and pressure from SLR. (Sea water will push against the coastal interface, causing the less dense groundwater to rise.)

Once the management goals and climate vulnerability stressors are identified, the next step is to identify the risks each climate change stressor poses. Risks are the reasonably foreseeable ways that climate change stressors could get in the way of the goals presented in Table 2. The risks were first identified by PEP staff and the Nation (following a presentation on the risk assessment process). Table 3 presents an example of the risks identified for Cultural Resources.

Table 3
Potential Effects of Climate Stressors on the Cultural Resources Protection Goal

Sea Level Rise (SLR)	More Frequent and Intense Storms	Warmer Waters	Increased Droughts	Coastal Acidification	Rising Groundwater Table	Warmer Atmosphere/ Changing Seasons
Storms have washed away some of the bluffs along the Great Peconic Bay at the Westwoods site, reducing the area for recreation and for ancestral practices such as fishing.	Storms have washed away some of the bluffs along the Great Peconic Bay at the Westwoods site, reducing the area for recreation and for ancestral practices such as fishing.	Warmer waters may increase invasive species, leading to the loss of culturally significant species	Increased droughts could lead to the loss of culturally significant native species	Ocean acidification may impact shellfish populations	Ancestral land nearest the water are at risk from rising tides and ponding water.	Climate changes will lead to the loss of culturally significant species. Already seeing the loss of sassafras and huckleberry
Ancestral land nearest the water is at risk from rising tides and ponding water.	Ancestral land nearest the water is at risk from storms.	Warmer waters may result in the loss of various fisheries	Droughts could increase invasive species and lead to the loss of culturally significant species	Reductions in shellfish populations could affect the production of Wampum for cultural purposes	A cemetery is located near a pond that has been expanding	Changes in seasons may increase invasive species and lead to the loss of culturally significant species.

Management goals, climate stressors, and risks were used in the vulnerability assessment conducted according to the process outlined in the Workbook, as explained in the following section.

2.3 Risk Categorization and Vulnerability Assessment

The final step of the assessment process is to rank the risks, then enter them into EPA's online tool in order to develop a consequence probability matrix to prioritize risks and determine vulnerability. For each risk identified, a qualitative scale using the following metrics outlined in the Workbook (USEPA 2014) was used to determine vulnerability: consequence, likelihood, time horizon, spatial extent, and habitat type. The qualitative scale enabled the use of a variety of resources in making vulnerability determinations, including regional climate projections, expert consultations, available data, and scientific reports. Consequence and likelihood were ranked 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 risks likely to happen sooner. Spatial extent was ranked by "site," "place or region," or "extensive."

Descriptions of each metric are as follows:

- **Consequence**: Each risk is considered against its perceived consequence for the Shinnecock Nation's goals and resources. Consequence is ranked as high if the risk's effect presents a major disruption and the goal in question could no longer be attained. A low-consequence risk needs some attention, but can be managed easily within the current management framework.
- **Likelihood:** The chance that a risk will occur is its likelihood. This metric considers current regulations, known management strategies, and planned projects. High likelihood means a risk is seen as all but certain to happen even when known management strategies and projects are considered. A low likelihood means a risk has the potential to happen, but its occurrence is unlikely based on known management strategies, specific environmental conditions, or research.
- **Time Horizon Until the Problem Begins:** The time horizon categorizes risk in terms of immediacy; risks expected to occur sooner are ranked higher than future risks with unknown time horizons.
- **Spatial Extent of the Impact:** The spatial extent categorizes a risk in terms of its geographic scope in the Nation's tribal lands and adjacent waterways using the following sub-categories:
    - Site (e.g., an individual community building or a protected parcel)
    - Place or region (e.g., Westwoods bluffs or the Neck's Living Shoreline)
    - Extensive (e.g., most of the watershed or most of the Nation's land)
- **Habitat Type:** Although habitat type is considered, it does not affect ranking. This factor is used more to flag risks unique to critical habitats.

The identified risks ranked qualitatively using USEPA's prioritization scheme were entered into the Workbook's companion 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.

For example, in assessing the risk to cultural resources posed by SLR, maps were produced to project SLR at the Neck (Figures 2 to 4). As shown in Figure 3, at 6 inches of SLR, the mean water level begins to inundate the Neck, including an area on western edge where a culturally significant cemetery is located. By the 2055 timeframe, with a CRRA projections of 21cinches, a portion of the cemetery would be inundated. Therefore, the consequence and likelihood of the risk was ranked as high with the time frame occurring within 10 to 30 years.

Risk tables are provided on the following pages (Tables 4 to 8).

Figure 2
Sea Level Rise Projections Results for the Neck at 6 inches of SLR (2025)

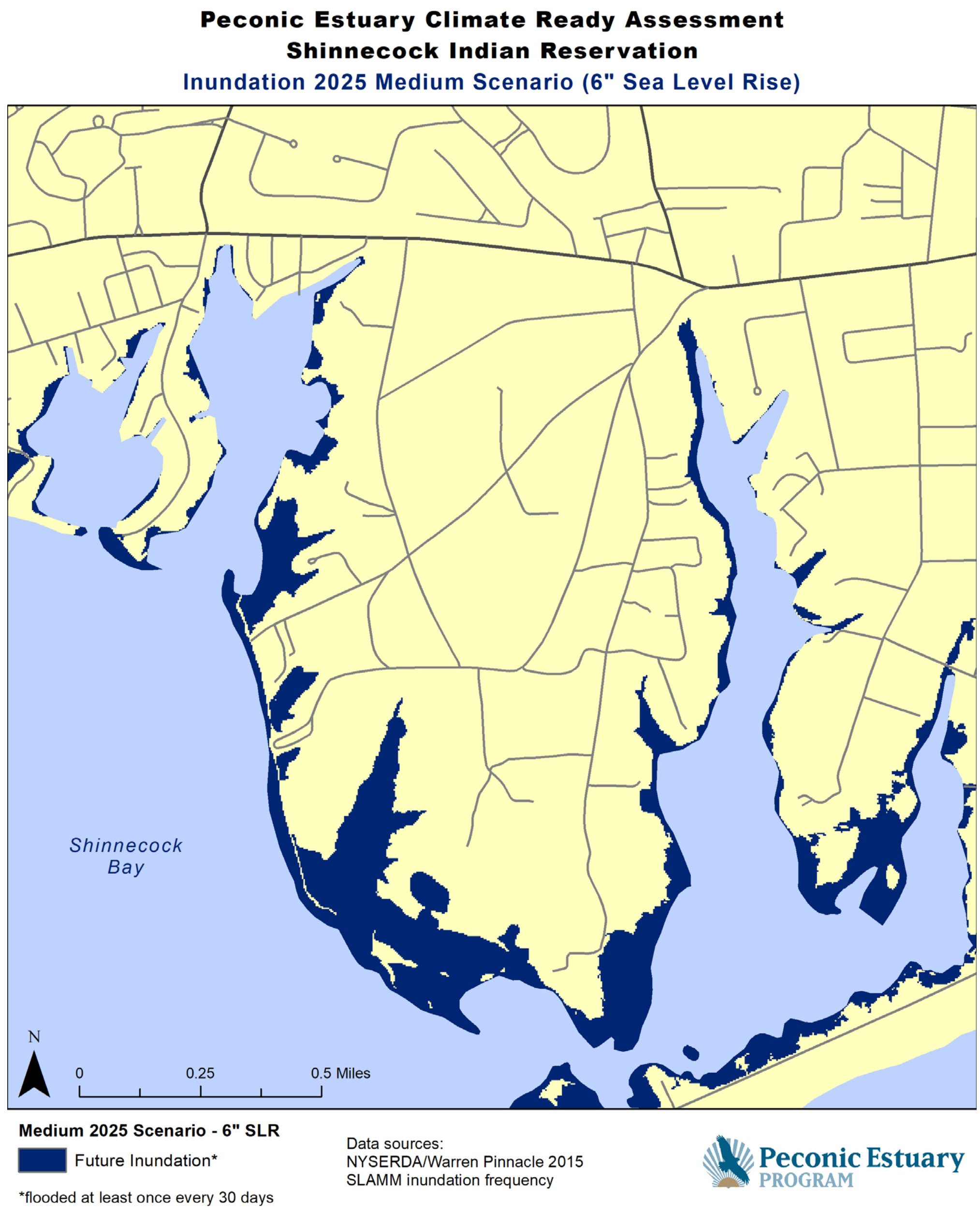


Figure 3
Sea Level Rise Projections Results for the Neck at 21 inches of SLR (2055)

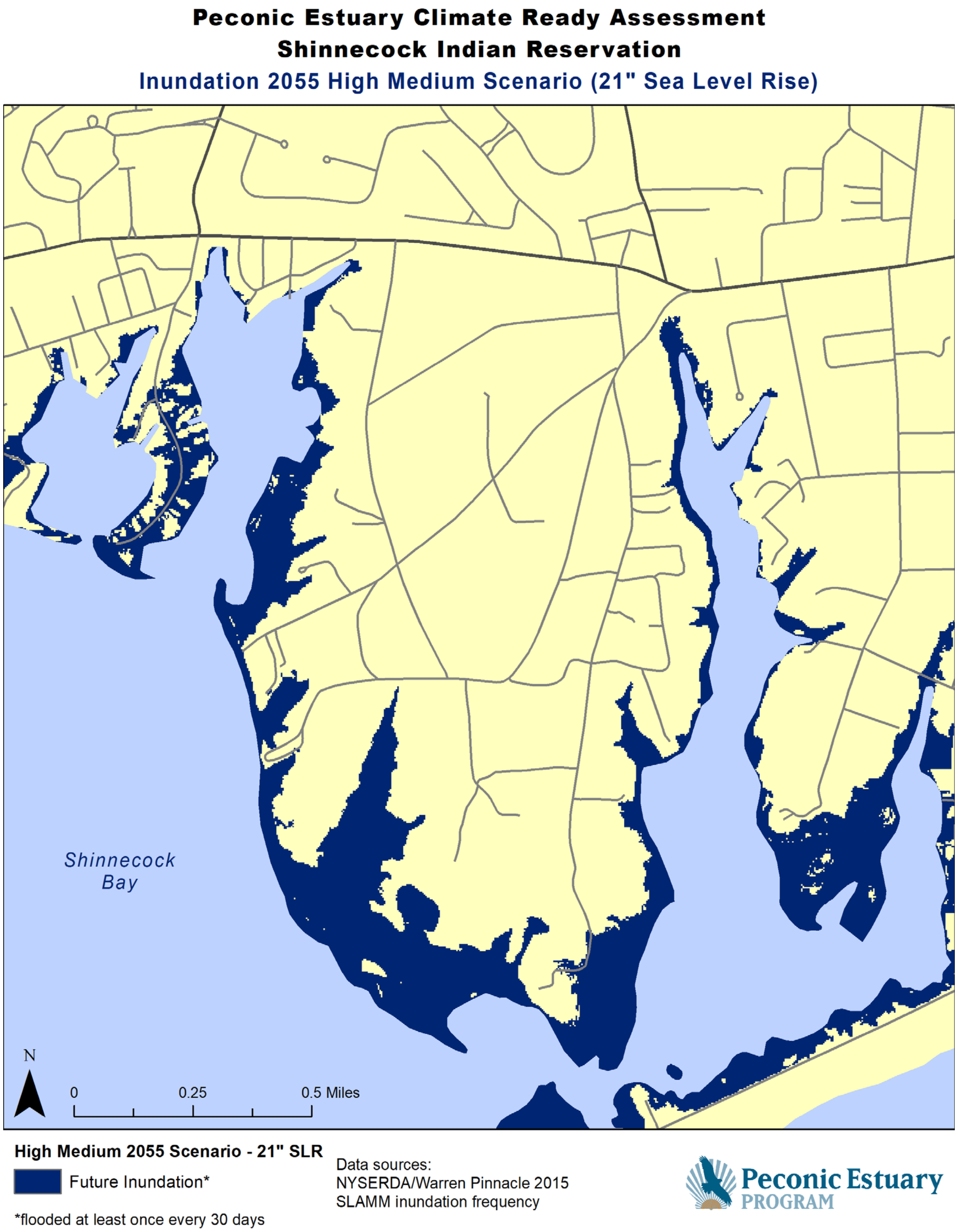


Figure 4
Sea Level Rise Projections Results for the Neck at 47 inches of SLR (2100)

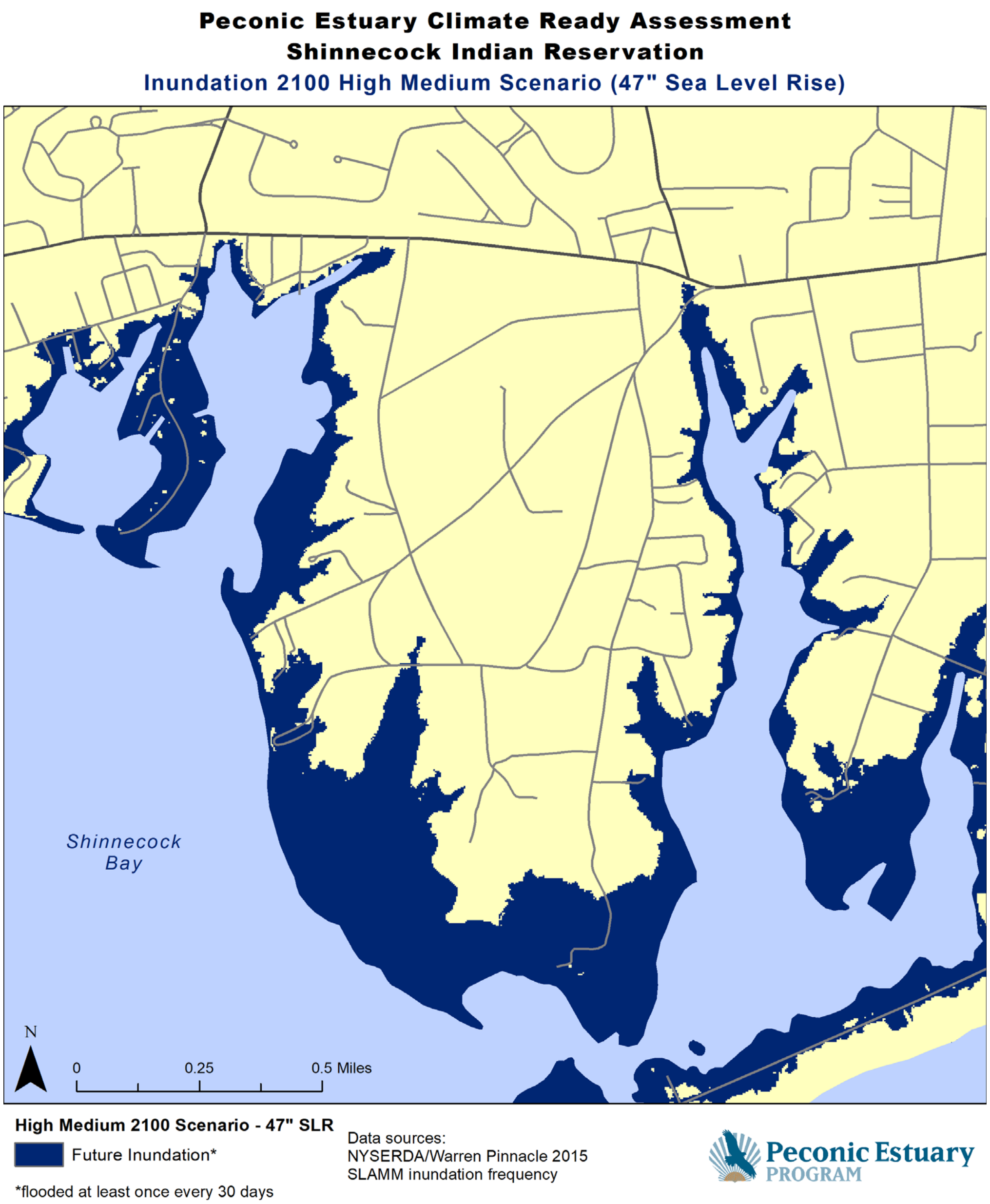


Table 4
Goal: Protect Residential Structures and Facilities

Likelihood	High		1. Rising groundwater table may bring septic systems closer to bay waters 2. Periods of extreme cold may require more heating needs. 3. More frequent and intense storms may threaten electricity connections 4. Sea level rise will bring septic systems closer to bay waters	1. Rising groundwater table may lead to loss of property and facilities due to sea level rise and rising groundwater table (ponding). For example a cemetery is located in close proximity to pond, which has been expanding 2. Sea level rise may result in loss of property and facilities
	Medium		1. Utility use and costs will increase (for example, the need for air conditioning will increase with hotter summers). 2. Freezing pipes are a concern with cycles of freeze and thaw 3. Sea level rise may lead to saltwater intrusion, which may affect drinking water for homes using wells	1. Increased drought may result in an increased risk of forest fires and loss of property
	Low			
		Low	Medium	High
		Consequence of impact		

Table 5

Goal: Protect Transportation Resources

Likelihood	**High**	1. Sea level rise may increase need for roadway maintenance	1. Rising groundwater table may lead to increased need for infrastructure (storm drains, culverts, etc.) and green infrastructure. 2. More frequent and intense storms may increase need for infrastructure (storm drains, culverts, etc.), maintenance and green infrastructure 3. Sea level rise may increase need for infrastructure (storm drains, culverts, etc.) and green infrastructure.	1. More frequent and intense storms may result in local access issues due to flooding, especially in emergency situations
	Medium	1. Warmer Atmosphere/ Changing Seasons could result in periods of extreme freezes and thaws, which could require more maintenance	1. Rising groundwater table may increase need for roadway maintenance/infrastructure 2. More frequent and intense storms may reduce connections to the larger transportation network on the South Fork 3. Sea level rise may reduce connections to the larger transportation network on the South Fork	1. Rising groundwater table may lead to local access issues due to flooding, especially in emergency situations 2. Sea level rise may result in local access issues due to flooding, especially in emergency situations
	Low			
		Low	**Medium**	**High**
		Consequence of impact		

Table 6
Goal: Protect Cultural Resources

Likelihood		Low	Medium	High
	High			1. Change in seasons may increase invasive species; leading to loss of culturally significant species. Southern pine beetles are already a threat to pine trees. 2. Changing climate will result in species changes, leading to loss of culturally significant species. Already seeing a loss of sassafras, huckleberry. 3. Changing climate will result in species changes, leading to loss of culturally significant species. Already seeing a loss of sassafras, huckleberry 4. Change in seasons may increase invasive species; leading to loss of culturally significant species. Southern pine beetles are already a threat to pine trees 5. Ancestral land nearest the water are at risk from storms. 6. Ancestral land nearest the water are at risk from rising tides and ponding water.
	Medium		1. Warmer waters may increase invasive species, leading to loss of culturally significant species 2. Warmer waters may result in possible loss of various fisheries	1. Ancestral land nearest the water are at risk from rising tides and rising groundwater table. For example, a cemetery is located in close proximity to pond, which has been expanding 2. Increased droughts could possibly increase invasive species, leading to loss of culturally significant species 3. Ocean acidification may impact shellfish populations. Reduction in shellfish populations could impact Wampum production for cultural uses 4. Reduction in shellfish populations could impact Wampum production for cultural uses
	Low			
		Low	**Medium**	**High**
		Consequence of impact		

Table 7
Goal: Protect Human Resources

Likelihood		Low	Medium	High
	High			
	Medium		1. Rising groundwater table will bring septic systems (on the Neck and in adjacent towns) closer to bay waters affecting water quality, which could pollute swimming waters and shellfish beds, especially if noticing does not include reservation 2. Warmer summers may lead to more air quality issues. Asthma and allergies affected by temperature, humidity and air pollutants. 3. Warmer temperatures may limit outdoor activities 4. Periods of extreme cold may require more heating needs 5. Ticks, mosquitos and other vector populations may increase with warmer temperatures, less winter freezes and more ponding, which may increase incidents of vector borne diseases such as Lyme disease and West Nile virus. 6. More frequent and intense storms may lead to runoff which could transport pathogens and non-point source pollution, both from the Nation's land as well as from adjacent lands 7. Sea level rise will bring septic systems (on the Neck and in adjacent towns) closer to bay waters affecting water quality, which could pollute swimming waters and shellfish beds	1. More extreme temperatures will affect human health. Elderly, sick and very young especially at risk in extreme heat 2. Increases droughts may affect water availability (Long Island wide) 3. More frequent and intense storms may threaten electricity connections and emergency access; especially threatening to people needing electrical connections for health needs and medical emergencies
	Low			
		Low	Medium	High
		Consequence of impact		

Table 8
Goal: Protect Water Quality and Natural Resources

Likelihood		Low	Medium	High
	High		1. More frequent and intense storms may increase erosion of shoreline habitat 2. More frequent and intense storms will lead to runoff which could transport pathogens and non-point source pollution, both from the Nation's land as well as from adjacent lands in Southampton and Hampton Bays	1. Warmer waters may lead to more harmful algal blooms in adjacent waters
	Medium	1. Warmer waters may result in species changes and loss	1. Sea level rise will decrease habitat (beach, wetlands, tidal flats etc.) areas if not able to migrate 2. Past vector control canals have led to eroded wetland areas, sea level rise could exacerbate loss. 3. Sea level rise may drown wetland areas. Wetlands may not be able to migrate in certain areas because substrate was lost	1. Rising groundwater table will bring septic systems closer to bay waters affecting water quality 2. Rising groundwater table may result in flooding of septic systems on the Neck and well as septic systems in neighboring communities, which may lead to more runoff into water. 3. Rising groundwater table may lead to more vector control in surrounding communities, which may lead to runoff of pesticides into the Tribe's waters and land 4. Changing seasons may lead to more harmful algal blooms in adjacent waters 5. Changing seasons may affect species diversity/loss. Already seeing a loss of sassafras, huckleberry and pitch pine 6. Changing seasons may increase invasive species Southern pine beetles are already a threat to pine trees 7. More frequent and intense storms may threaten the new living shoreline project 8. Sea level rise and coastal erosion may threaten the new living shoreline project 9. Ocean acidification may impact shellfish populations
	Low		1. Increased drought may result in an increased risk of forest fires and loss of valued forest species	
		Low	**Medium**	**High**
		Consequence of impact		

The high risks identified in the above tables were carried forward into the adaptation process.

2.4 Adaptation Planning

The goal of adaptation planning is to reduce the risk climate change poses to the Nation's resources and management goals. The Shinnecock Nation's Climate Change Action Plan helped identify risks and early adaptation strategies. The adaptation strategies discussed in the next section will be added to the plan and the tribe's planning efforts. As shown in the risk tables, risks often overlap because many of the management 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 risks.

The Nation'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 strategy plan based on prioritization. Responding to high risks is the top priority because they are very likely to happen and will have great 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 also addresses—or at least begins to address—medium and low risks.

2.4.1 Evaluating Adaption Actions and Strategies

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

Adaptation actions selected by the Nation include projects that emphasize soft or green engineering to restore and enhance natural systems and habitat functions and are amenable to incorporating 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. They are often more cost effective than hard structural responses, and they offer added flexibility in responding to climate change impacts. For example, stormwater retention ponds can 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 possible, so wetlands can move inland in the face of rising sea level and greater storm surges. Living shorelines and other nature-based solutions can improve not only coastal resiliency and erosion control but also water quality by filtering pollutants in runoff, and they can create or maintain important habitat, improve waterfront access and recreational opportunities, and enhance aesthetics. Several adaptation action projects are described in more detail in the following sections.

2.4.1.1 Habitat Creation and Restoration

Living Shorelines: Living shorelines are a nature-based approach to shoreline stabilization that is more cost effective and ecologically preferable than hardened shorelines. 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). The Nation partnered with the Cornell Cooperative Extension and Suffolk County to construct a 3,000-acre coastal habitat restoration project that includes a living shoreline. Expanding such efforts would help the Shinnecock achieve their resiliency goals.

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 support species diversity. Restoration involves amending a wetland's physical, chemical, or biological characteristics to restore the ecosystem services it provides. The Nation's lands include wetlands that have been channelized for vector control and culverted for stormwater control. Restoration of these wetlands to their natural state could help decrease flooding in adjacent areas, especially at the cemetery and in areas of roadway subject to flooding.

Forest Restoration and Management: Forests in the Westwood area include species important to the Nation's cultural practices. Drought and invasive species can stress forests, reduce the availability of culturally important plant species, and heighten the risk of forest fires during dry periods. Forest management strategies may help reduce risks. In addition, healthy forests store more carbon, helping mitigate some of the effects of climate change. Plants also help move moisture into the air. The 79-acre Westwoods property is a relatively large parcel of undeveloped land on the South Fork; active forest management strategies, such as restoring native vegetation and wildlife habitat and controlling over-grazing, can enhance the health of this land.

Seaweed Farming: Other than reducing global levels of atmospheric carbon dioxide (CO_2), options to reduce oceanic acidification are limited, but kelp farming has the potential to elevate pH locally through CO_2 uptake and by harvesting before the kelp dies, decomposes, and releases the CO_2 it has captured (Duarte et al. 2017). PEP conducted a Seaweed Aquaculture Feasibility Study in 2017 to evaluate the viability of sugar kelp to sequester nitrogen and carbon from the water column while producing a renewable product. Although productivity was limited, the study provided valuable data that may be used as a starting point for larger scale operations. Kelp farming could also provide new employment opportunities. An article in the Summer 2018 issue of *Edible East End* titled "Kelp. Its What's for Dinner" highlighted several East End restaurants interested in adding kelp to their menus (Singh-Roy 2018).

2.4.1.2 Green Infrastructure Projects

Addressing climate change will require comprehensive municipal planning and projects. Although the Shinnecock may be able to address some immediate and long-term needs through green infrastructure, focusing on the short term may overshadow long-term planning. One way to avoid this situation is to make climate change part of emergency risk management. Emergency risk management funds might be leveraged to address current and near-term risks posed by climate change, thus freeing resources for longer term climate-change-specific planning. Although resources are limited, grants and other source of funding discussed in Section 2.5 may be available.

Promote Stormwater Infiltration: Bioretention basins, rain gardens, swales, and other structures that promote stormwater infiltration help remove nutrients, pathogens, and toxins from stormwater before it reaches groundwater and Shinnecock Bay. Although rain gardens and swales are less effective than other bioretention techniques, they can be cost-effective for small-scale retention projects. Stormwater infiltration helps achieve water quality goals and can also assist with flood control. Such strategies should be evaluated for implementation at the Neck.

Cooling and Heating Centers: Cooling centers and heating centers provide respite and safety during extreme heat and extreme cold. Such centers may have redundant power sources to ensure climate control in times of power outages. They may also have resources such as water, for extra hydration, and blankets to ensure adequate support for users most susceptible to climate extremes. The Shinnecock Community Center could be used to provide members comfort during extreme temperatures.

Energy Conservation and Renewable Energy: Climate-change adaptation strategies include greater use of renewable sources of energy such as solar panels and wind turbines, which can supply electricity at lower direct costs, and energy conservation measures, often identified by energy audits. Such strategies can help mitigate some of the emergency risks of climate change by reducing electricity outages.

Septic Upgrades: Wastewater discharges from cesspools and septic systems are the largest source of nitrogen in area waterbodies, and SLR has the potential to exacerbate the problem by decreasing the time for groundwater to travel to the bays. In response, Suffolk County, PEP, and several towns are promoting cost-effective septic upgrades. Suffolk County's Subwatershed Wastewater Plan (Suffolk County 2016) identified priority watersheds for nitrogen reduction. The county is also promoting residential Innovative and Alternative Onsite Wastewater Treatment Systems by offering financial incentives through its septic improvement program. Working with the county, the Shinnecock may be able to secure funding to promote systems for residences on the Neck.

2.4.1.3 Land Conservation

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. Although the tribal lands are community property, certain parcels on the Neck may be targeted for preservation to ensure a buffer between changing coastal dynamics and built structures. GIS imaging of future climate projections on Tribal land could help identify such parcels.

2.4.1.4 Outreach and Education

Public outreach and education will be a key part of climate adaptation planning because many of the adaptation actions and strategies discussed previously require comprehensive planning and resources and so will also require strong public buy-in and support. Engaging with climate change can be challenging. Data from complex modeling can be hard to translate into easy-to-understand actions. The effects of climate change can be so daunting, solutions seem out of reach. Shared values about the importance of the environment will promote climate planning. Addressing climate actions as sustainability actions that serve the people and the long-term economic goals of the tribe will help garner support for them. For example, energy conservation and renewable energy can not only save money in the long run, but also provide a reliable supply of energy to help with emergency and day-to-day planning.

2.4.2 Screening Adaptation Actions and Strategies

Each potential adaptation action and strategy was screened to determine whether it is 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 9. Prospective actions and strategies deemed most feasible have the fewest barriers to implementation and will be included in the Shinnecock Nation's Climate Adaptation Plan.

As shown in Table 9, some adaptation actions were deemed not feasible and adaptation actions to address 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. Opportunities to overcome barriers were also identified and considered in collaboration with stakeholders. For example, social barriers include the lack of public consensus on climate risks, the lack of awareness of environmental issues, and the lack of limits on the number of tourists visiting the region—plus the fact that the more extreme, future effects of climate change effects may be hard to grasp. The graphics developed during the Critical Lands Protection Strategy 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 9
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?
Rising groundwater table may lead to loss of property and facilities due to rising groundwater table (ponding).	Flood Protection (Soft/Green Engineering) including Stormwater Infiltration	Yes	Yes	Yes
	Land Conservation	Yes	Yes	Yes
Sea level rise may result in loss of property and facilities	Flood Protection (Soft/Green Engineering), including Living Shorelines/Habitat Restoration	Yes	Yes	Yes
	Land Conservation	Yes	Yes	Yes
Ancestral land nearest the water are at risk from storms.	Living Shoreline	Yes	Yes	Yes
More frequent and intense storms may result in local access issues due to flooding, especially in emergency situations	Evacuation Plans	Yes	Yes	Yes
Increased drought may result in an increased risk of forest fires and loss of property	Forest Management	Yes	Yes	Yes
Change in seasons may increase invasive species; leading to loss of culturally significant species. Southern pine beetles are already a threat to pine trees	Forest Management	No	Yes	Yes
More frequent and intense storms may increase need for infrastructure (storm drains, culverts, etc.), maintenance and green infrastructure	Flood Protection (Soft/Green Engineering) including Stormwater Infiltration and Habitat Restoration	No	Yes	Yes
More frequent and intense storms will lead to runoff which could transport pathogens and non-	Promote Stormwater Infiltration	Yes	Yes	Yes

Risk Selected for Mitigation	Potential Adaptation Action	Could the action reduce likelihood*?	Could the action reduce consequence*?	Appropriate to Proceed with this Action?
point source pollution, both from the Nation's land as well as from adjacent lands in Southampton and Hampton Bays	Wetland Restoration	Yes	Yes	Yes
More frequent and intense storms may increase erosion of shoreline habitat	Living Shoreline	No	Yes	Yes
Rising groundwater table may lead to local access issues due to flooding, especially in emergency situations	Evacuation Plans	No	Yes	Yes
Ocean acidification may impact shellfish populations. Reduction in shellfish populations could impact Wampum production for cultural uses	Seaweed Farming	No	Yes	Yes
More extreme temperatures will affect human health. Elderly, sick and very young especially at risk in extreme cold or heat	Energy Conservation Cooling Centers, Warming Centers	No	No	Yes
Increased droughts could affect native species, leading to loss of culturally significant species	Habitat Restoration	No	Yes	Yes
Increases droughts may affect water availability	Cisterns and Rain Gardens Municipal Water Connections	No	Yes	Yes
More frequent and intense storms may threaten electricity connections especially threatening to people needing electrical connections for health needs and medical emergencies	Solar Power Emergency Storm Plans/Storm Shelters	No	Yes	Yes
Changing climate will result in species changes, leading to loss of culturally significant species	Habitat Restoration	No	Yes	Yes
Warmer waters may lead to more harmful algal blooms in adjacent waters	Promote Septic Upgrades	Yes	Yes	Yes

The final step in adaptation planning was to select strategies based on the screening process. Adaptation planning emphasized measures that would address multiple risks and support multiple goals and that built on existing strategies in order to address feasibility concerns. Table 4 presents the adaptation actions from Table 10 that were deemed appropriate to proceed with, other adaptation efforts by the Shinnecock and partner organizations that are underway, and an assessment of their ability to meet the Nation's goals.

Table 10
Potential Adaptation Actions and Strategies

	Protect Residential Structures and Facilities	Protect Transportation Infrastructure	Protect Cultural Resources and Practices	Protect Human Health	Protect Water Quality and Natural Resources
Living Shorelines	●	●		●	●
Habitat Restoration	●	●	●	●	
Forest Restoration and Management			●		●
Seaweed Farming			●		●
Land Conservation			●	●	●
Green Infrastructure Projects	●	●	●	●	●
Promote stormwater infiltration	●		●		
Promote Septic Upgrades	●		●	●	●
Promote Energy Conservation		●	●		
Promote Water Conservation and Reuse		●	●		
Media Outreach	●	●	●	●	●

2.5 Incorporating Adaptation Actions in Climate Action Plan

Many of the adaptation actions and strategies discussed previously will be incorporated into the existing Climate Change Adaptation Plan. Some of these actions and strategies have already been implemented by Shinnecock.

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. The Shinnecock Nation and its partner organizations can use the selected funding opportunities listed in Table 11 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 to track projects awarded in the region.

Table 11
Funding Opportunities

Funding Opportunity	Funding Agency	Proposal Timing	Website	Applicable Adaptation Action(s)
Resilient Communities Program	National Fish and Wildlife Foundation (NFWF)	Annually, January	https://www.nfwf.org/Resilient Communities/Pages/home.aspx	Living Shorelines Wetland Restoration
National Coastal Resilience Fund	NFWF	Annually, Spring	https://www.nfwf.org/coastalresilience /Pages/home.aspx	Living Shorelines Wetland Restoration
Wetland Program Development Grants	USEPA EPA	Annually, Spring	https://www.epa.gov/wetlands/ wetland-program-development-grants-and-epa-wetlands-grant-coordinators	Wetland Restoration
North American Wetlands Conservation Act Grants	USFWS	Annually, February	https://www.fws.gov/birds/grants/ north-american-wetland-conservation-act.php	Land Acquisition and Conservation Wetland Restoration Habitat Restoration
Atlantic Coastal Habitat Partnership	ACHFP	Annually, August	http://www.atlanticfishhabitat.org/ opportunities/funding/	Living Shorelines Habitat Restoration Create Deep Pools
Coastal and Marine Habitat Restoration Grants	NOAA	Annually, January	https://www.fisheries.noaa.gov/grant/ coastal-and-marine-habitat-restoration-grants	Wetland Restoration Habitat Restoration
Climate Smart Communities	NYSDEC	Annually, July	https://www.dec.ny.gov/energy/ 109181.html	Promote Energy Conservation Promote Water Conservation and Reuse Living Shorelines Wetland Restoration
Water Quality Improvement Project Plan	NYSDEC	Annually, Summer	http://www.dec.ny.gov/pubs/4774.html	Promote Stormwater Infiltration Promote Septic Upgrades Land Acquisition and Conservation

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