

Appendix C: Vulnerability Assessment



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Introduction

Climate change brings a range of hazards to Maine that threaten our health, infrastructure, and environment—but local solutions are within reach. At a community scale, we can build capacity to adapt to present, and projected, climate hazards and their resulting impacts. We can build local climate resilience by reducing existing vulnerabilities and take steps to mitigate future hazards. Towards this end, the Town of Freeport is undertaking an effort to assess and adapt to the threats climate hazards bring, both now and into the future.

The information presented in this report is compiled from local, regional, state, and national data; interviews with municipal department heads; public input including surveys, workshops, and community conversations; and collaboration with Freeport town staff and the Freeport Sustainability Advisory Board.

The purpose of this assessment is to:

- *Identify the hazards that Freeport will likely face due to climate change*
- *Provide a baseline for the community resources, infrastructure, and natural resources most at risk to climate impacts*
- *Inform Freeport's Climate Action Plan to better identify adaptation strategies*
- *Be adaptive, with the ability to be updated as new information becomes available*

This assessment is not:

- *Designed to dive into site-specific vulnerabilities but rather point to areas that may need further study*
- *An indicator of definitive problems that will occur but provides guidance on what could be most at risk in the coming years due to climate change.*

Hazard	Impact	Stressor	Shock
A physical process or event, exacerbated by climate change, that can bring harm to people, communities, or ecosystems	The potential effect a climate hazard can have on human or natural assets and systems	A chronic condition or trend related to climate change that can exacerbate pre-existing hazards	Acute events occurring over a specific period of time, such as heat waves or dangerous weather events, made more severe or frequent by climate change
Risk	Vulnerability	Adaptation	Resilience
The potential for negative consequences where something of value is at stake. In the context of the assessment of climate impacts, risk can be assessed by multiplying the probability of a hazard by the magnitude of the negative consequence or loss.	A measure of risk to a threat, incorporating the likelihood of the threat occurring and the severity of the impact if it occurs	The process of adjusting to or preparing for changing conditions to reduce the vulnerability of impacted assets	The capacity of communities or natural environments to adapt and/or recover quickly from impacts ¹

¹ <https://toolkit.climate.gov/content/glossary#:~:text=A%20condition%2C%20event%2C%20or%20trend,change%20that%20can%20exacerbate%20hazards>

Data and Methodology

This report relies on national, state, regional, and local data to assess climate hazards, historical records, future projections, and impacts on local assets. There is currently limited hyper-local data on climate hazards and much of the modeling to predict future conditions is being done at the regional or state level. Therefore, this assessment relies on information from The Maine Climate Council's Scientific and Technical Subcommittee "[Scientific Assessment of Climate Change and Its Effects in Maine](#)" and the regional analysis of hazards conducted by partner organizations such as Casco Bay Estuary Partnership, Friends of Casco Bay, and Gulf of Maine Research Institute. Since there is a lack of localized data collection tools (tide gauges, weather service stations, etc.), this assessment uses regional data with specific discussions of Freeport's particular context when possible².

The data analysis for this vulnerability assessment generated quantitative-based information on how infrastructure, community services, and natural resources in Freeport are exposed to climate hazards. When assessing specific vulnerabilities, this report uses Town-provided data—both quantitative and qualitative—where available and is supplemented with state provided data analyzed at the local level.

This assessment uses the best available data and modeling tools; however, every dataset has limitations. The State of Maine and regional partners are continuing to research climate change and provide updated models, data, and resources. As improved data and more powerful models become available, this vulnerability assessment will need to be updated and refined.

Uncertain Climate Future

Climate change scenarios and pathways are developed to explore future emissions, related impacts and risks, and possible mitigation and adaptation strategies. These modeled scenarios and pathways are based on a range of assumptions including socio-economic variables and mitigation, and only provide a hypothetical future that could unfold given the presence or absence of climate policies. Therefore, how communities mitigate, prepare for, and adapt to climate change will impact what the future will look like. To read more about potential climate change scenarios, please visit the [IPCC's most recent climate assessment](#) and the [Fifth National Climate Assessment](#).

Sea Level Rise

The Maine Climate Council recommends taking a scenario-based approach which considers a range of potential future sea levels and adopts the approach of committing to manage for a higher probability, lower risk scenario, but also preparing to manage for a lower probability, higher risk scenario. The State recommends committing to manage for 1.5 feet of relative sea level rise by 2050, and 3.9 feet of sea level rise by the year 2100, but preparing to manage for 3.0 feet by 2050, and 8.8 feet by 2100.3

For this report, we looked at two different sea level rise scenarios: Highest Astronomical Tide (HAT)+1.6 feet and HAT+3.9 feet of sea level rise. These datasets, available from the Maine Geological Survey, both align with the State's recommendation of committing to manage 1.5 feet of rise by 2050 and preparing to manage 3.0 feet by 2050⁴. Assets which show flooding under either of these scenarios means that water will be frequently seen inundating these locations during high tides.

See Attachment A for more information on sea level rise and 100-year flooding data.

² Examples include tide gauges or air quality monitoring sites in Portland

100-Year Flooding Events

To determine the impacts of 100-year floods, particularly along inland waterways, this report uses 2050 projected 100-year flooding data from First Street Foundation's Flood Factor 5 rather than FEMA Floodplain Management. While FEMA floodplain information reflects current estimates and historic flood risk, it does not project future risk under a changing climate. Most notably, it does not take into account increased precipitation. Flood Factor includes flooding from all types in its application – rain, river, tidal and storm surge. According to First Street Foundation, by not accounting for precipitation, FEMA's Special Flood Hazard Area (SFHA) designation leaves over half of the country's risk unaddressed.⁶ However, Flood Factor uses a single methodology on a national scale, which may limit the accuracy at a local level. Currently this is the best available data, but it should be checked frequently and updated as new and better data is created.

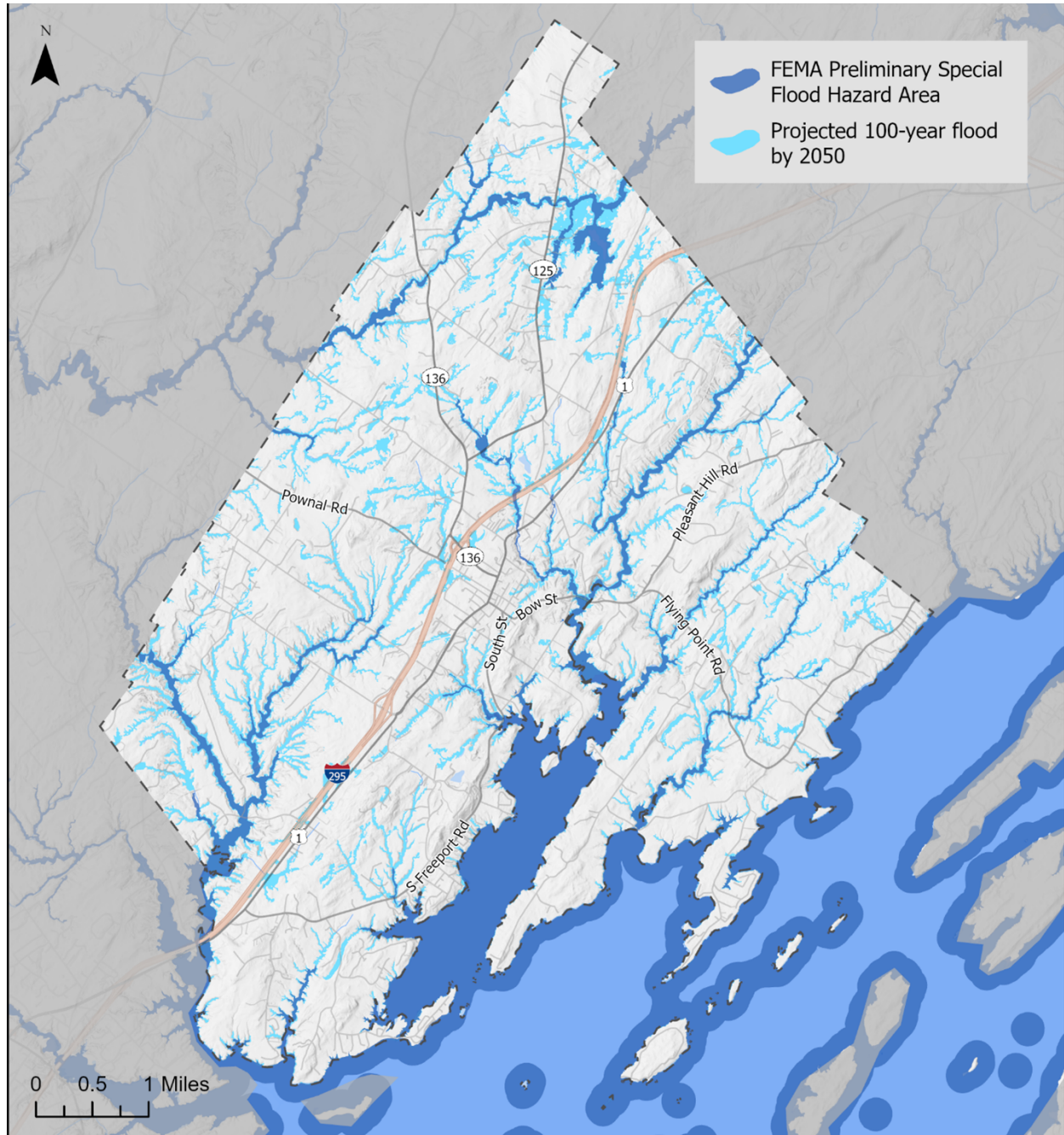


Figure 1: Comparison between FEMA Special Flood Hazard Areas (dark blue) compared to FloodFactor (light blue). Unlike FloodFactor, FEMA does not take sea level rise or increased precipitation into consideration. Source: FEMA, FloodFactor

Climate Hazards

Like many other coastal towns, Freeport is already beginning to experience warmer air temperatures, increased precipitation, more severe storms, and sea level rise from climate change. Climate hazards degrade infrastructure and pose risks to people, ecosystems, and infrastructure.

This section provides information on the following climate hazards Freeport will face:

- Warming, more variable temperatures
- Changing precipitation patterns
- Sea level rise
- Changing ocean conditions

Freeport is not alone in experiencing climate hazards and their resulting impacts. The Casco Bay region and state are experiencing similar trends across all hazards. Since local data is not available, this section relies primarily on regional and state data to assess the historical trends and future projections.

What is the Freeport community concerned about?

This is the information

Warmer, More Variable Temperatures

Rising concentrations of greenhouse gases in the atmosphere increase the average annual global temperature. While all regions of the globe will experience impacts from climate change, the northeastern region of the United States is warming at a faster rate than the global average ⁷. Maine has already experienced an average annual temperature increase of 3.2 degrees Fahrenheit compared to 1895 ⁸. **Every year since 1997 has been above the yearly average** ⁹.



As a coastal community, Freeport has experienced slightly more warming than the state average and is projected to have annual temperatures 3.5 to 4 degrees Fahrenheit higher than 1895 by 2050 ¹⁰.

Impacts

Humans

- Increased heat-related illnesses
- Increased vector-borne diseases (i.e. Lyme)
- Strain on the health care system
- Worsening air pollution
- Shift in tourism seasons

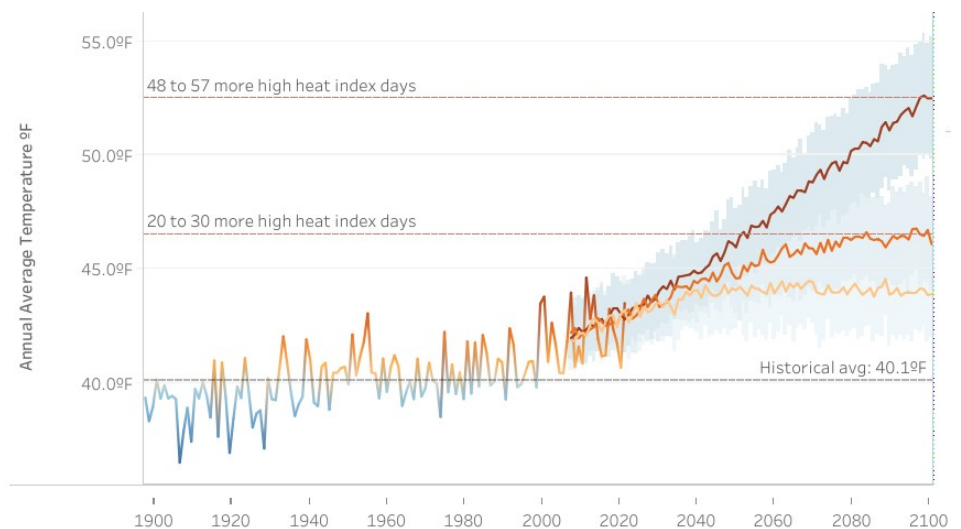
Infrastructure

- Increased buckling, softening, and cracking of roadways
- Increased energy consumption

Ecosystem

- Agricultural shifts
- Increased frequency of pest outbreaks
- Shifting ecosystems (i.e. invasive species)

The change in temperature disrupts the seasonal patterns of the region. As temperatures increase, the warm seasons (when the average daily temperature is above freezing) become longer and the cool seasons become shorter. Global climate projections indicate that Maine's warm season will be two weeks longer by 2050 ¹¹. This is coupled with a projected increase in days with a high heat index. The National Weather Service recorded seven high heat days in the region in 2021 (temperatures reached or exceeded 90°F), an increase from the four recorded in 2019 ¹². The region will experience 20 to 30 more high heat days annually by 2050 and the winter season will shrink by one to two weeks ¹³.



SOURCE: NOAA (land temperatures); Maine State Climate Office (CMIP5 model projections).

Figure 2: Average Annual Temperature in Maine from 1895 to 2022 and projected temperature increase based on three different RCPs. Source: Maine Climate Dashboard

7 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0168697#sec003>

8 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

9 <https://www.maine.gov/future/climate/climate-impact-dashboard>

10 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

11 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0168697>

12 <https://www.weather.gov/wrh/Climate?wfo=gyx>

13 <https://www.mainepublic.org/environment-and-outdoors/2022-02-16/maine-winters-are-shortening-thats-raising-existential-questions-for-the-states-snowmobilers>

Changing Precipitation Patterns

Higher temperatures will increase water evaporation from oceans and freshwater sources, resulting in overall higher humidity. Warmer air holds more moisture causing precipitation events to become more frequent and intense. By tracking annual precipitation patterns, the University of Maine determined that rainfall in Maine has increased 15% since 1895. This trend will likely continue, with a projected 5% additional increase in precipitation by 2050 ¹⁴.

Not only will total annual precipitation increase, but the frequency of heavy storms will increase. Since the late 1990's the northeastern U.S. has also experienced more frequent heavy precipitation events, primarily in summer and fall ¹⁵. A study in Farmington, Maine found that the area experiences 10–15 more precipitation events in a year than during the previous century and more of these events are large rain events ¹⁶. Additionally, The University of Maine completed assessments that indicate Nor'easters, ice storms and/or bomb cyclones – a rotating system of clouds that grows into a rapidly intense storm due to a sudden drop in atmospheric pressure- will become more frequent ¹⁷.

While average annual precipitation is projected to increase, warmer overall temperatures and less snowpack will create the conditions for longer periods of drought. Between periods of precipitation, warmer temperatures will cause higher evaporations rates for lakes, rivers, and other water bodies. Maine is considered a “wet” state but has experienced 35 statewide droughts since 1990 ¹⁸. The changing atmospheric conditions of the state will increase the occurrence of one-to-three-month droughts and reduce summer stream flow ¹⁹.

Impacts

Humans

- Changes in property and municipal tax base
- Decline in water quality

Infrastructure

- Coastal and inland flooding
- Coastal and inland erosion
- Overburdened wastewater systems
- Building and roadway damage

Ecosystem

- Agriculture damage
- Decline in ecosystem health
- Wildfires

Maine Statewide Annual Total Precipitation (in)
Data Source: NOAA Climate Divisional Database | Chart: Maine Climate Office

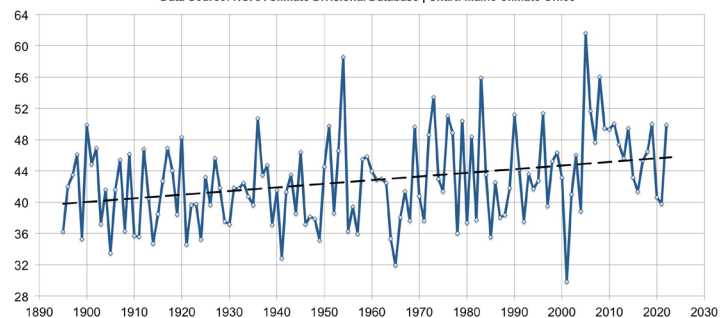


Figure 3: Maine Statewide Annual Total Precipitation in inches. The linear trend (dashed line) indicates total precipitation has increased by 6 inches over this time period. Source: Maine Climate Office, https://mco.umaine.edu/pubs/climate_summary/

Current Events

The region has experienced several intense rainstorms in the Winter 2023-2024 season. The storm on December 23rd caused extensive flooding, power outages, and damage to coastal communities in Cumberland and York Counties. Winds up to 70 miles per hour and waves over 13 feet were recorded in towns neighboring Freeport during this storm. The second week of 2024 brought back-to-back storms, with intense winds and waves causing damage along the coast. Freeport reported nearly 8 inches of snow. The rise in both frequency and intensity of storms indicates that this region is already experiencing the impacts of a warming climate.

Although overall precipitation will increase, annual snowfall will decline as temperatures rise. Since 1895, the average amount of snowfall in a year has decreased by 20% and the duration of snowpack has also decreased by two weeks. Coastal Maine is likely to experience 50% less snowpack by 2050 under the conditions of the IPCC's medium emission scenario ²⁰. **As a result, the region will see more inches of rainfall annually, but it is projected to be concentrated in more intense storms with periods of increased drought in between.**

14 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

15 https://mco.umaine.edu/pubs/climate_summary/#:~:text=On%20average%2C%2010%20to%2015,total%20annual%20precipitation%201895%E2%80%932022

16 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

17 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

18 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

19 [https://www.maine.gov/dacf/municipalplanning/docs/NortheastClimateImpactsAssessment\(MaineSummary\).pdf](https://www.maine.gov/dacf/municipalplanning/docs/NortheastClimateImpactsAssessment(MaineSummary).pdf)

20 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

Sea Level Rise

Global average sea level has increased by roughly 7-8 inches since the early 1900s, with almost half of that rise occurring since 1993 ²¹.

The water levels in Casco Bay have risen by 7.5 inches since record-keeping began in 1912. While sea levels had been rising at a rate of 0.07 inches per year, that rate has accelerated to 0.12 inches since 1990 ²². This rate equates to about 1 foot of sea level rise per century but is predicted to accelerate further, as climate change worsens.

Higher sea levels mean higher tides reach further inland, causing more frequent “sunny day” or “nuisance” flooding, defined as when coastal water levels reach or exceed 2 feet above the long-term average daily high tide. In Greater Portland, nuisance floods historically happened about five times per year, but lately have occurred 12 or more times a year, especially during winter Nor’easters ²³.

Assessments from the State estimate that by 2050, at least a 1-foot rise in sea level will lead to an increase of 98 flooding events per year in Portland ²⁴. Depending on various climate change scenarios—that is how greenhouse gas emissions and socio-economic development change— sea levels may rise to over 3 feet in 2050 and over 8 feet in 2100.

Impacts

Humans

- Changes in property and municipal tax base
- Contaminated groundwater

Infrastructure

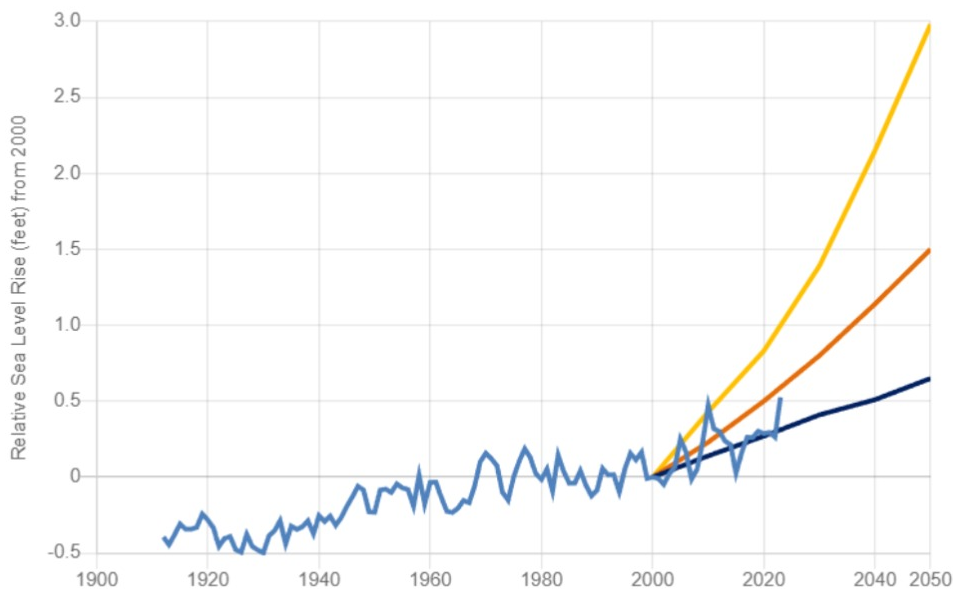
- Coastal and inland flooding
- Coastal erosion
- Strain on stormwater systems

Ecosystem

- Shifting ecosystems
- Changing groundwater levels and salt accumulation in soil

Annual Sea Levels Referenced to 2000, NOAA Station 8418150, Portland undefined

— = Low — = Intermediate — = High Scenarios
— = Long Term Data



NOTE: The intermediate scenario is the “commit to manage” and the high scenario is the “plan to prepare” level in the Maine Won’t Wait Climate Plan. Low, Intermediate, and High scenarios are based on Sweet et al., 2017.

Figure 4: Annual sea level rise at the Portland tide gauge from 1912 to 2022. The trend lines so potential rise based on low (blue), intermediate (orange), or high (yellow) sea level rise scenarios. Source: Maine Sea Level Rise Dashboard

21 https://www.oneclimatefuture.org/wp-content/uploads/2020/12/OneClimateFuture_VulnerabilityAssessment_Final.pdf
22 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climates-Future-2020-Update-3.pdf>
23 <https://ntrs.nasa.gov/citations/20180001857>
24 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climates-Future-2020-Update-3.pdf>

Rising Ocean Temperatures and Acidification

Ocean temperatures in the Gulf of Maine have been rising at an accelerating rate, warming three times as fast as the global average over the past three decades, and seven times as fast in just the past 15 years²⁵. Between 2004 and 2013, the Gulf of Maine warmed by 0.41°F (0.23°C) per year, a rate faster than 99% of the world’s oceans. Bodies of water along the Maine coast are expected to continue warming at an above average rate; water temperatures in Casco Bay have increased over 2.5°F (1.4°C) between 1993 and 2022. The Gulf of Maine experienced its warmest year on record in 2021, with an average surface temperature of 54.1°F- coming in just ahead of 2022 as the second warmest year with an average surface temperature of 53.7°F²⁶.

Oceans act as a “carbon sink,” absorbing atmospheric carbon dioxide, thus helping alleviate the impacts of climate change. As the atmospheric concentration of carbon dioxide rises, the ocean absorbs more carbon dioxide, causing the water to become increasingly acidic. Acidification is further increased by stormwater runoff with prominent levels of nutrients such as nitrogen, creating algal blooms which can release toxins harmful to humans and marine species. Acidification impacts the health of the ocean and harms marine life.

Globally, oceans have become 30% more acidic in the past 100 years²⁷. The Gulf of Maine may have a higher susceptibility to ocean acidification because of its relatively low pH and colder waters, which more readily absorb carbon dioxide. Research predicts that the acidity of the Gulf of Maine will continue to increase rapidly in the coming decades and at a faster pace than the global average²⁸.

Impacts

- Humans
 - Strain on food supply
- Ecosystem
 - Decline in marine species health, particularly shellfish
 - Harm to fishing industry

Rising Water Temperatures

Friends of Casco Bay Sentinel Site Temperature Data
May through October Annual Averages

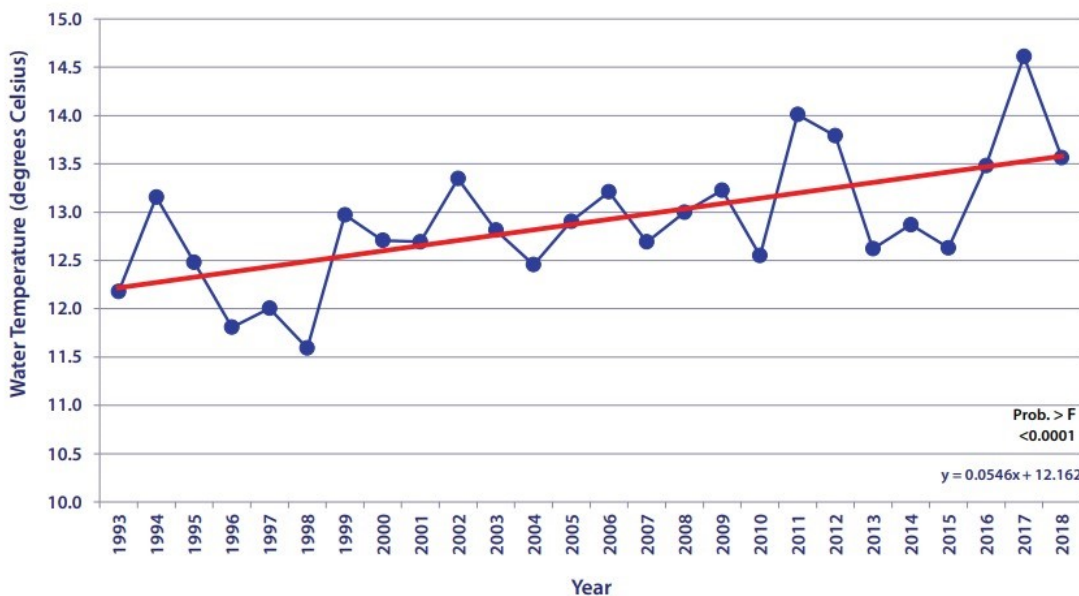


Figure 5: Average annual water temperature in Casco Bay from 1993 to 2019. Data is taken from Friends of Casco Bay’s three Sentinel Sites, which are located offshore in Broad Sound, nearshore by Clapboard Island, and at the mouth of Portland Harbor. Source: Frie

25 https://www.oneclimatefuture.org/wp-content/uploads/2020/12/OneClimateFuture_VulnerabilityAssessment_Final.pdf
 26 <https://www.gmri.org/stories/warming-22/#~:text=Highlights%20from%20Another%20Remarkably%20Warm,year%20on%20record%20in%202022.>
 27 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>
 28 https://www.oneclimatefuture.org/wp-content/uploads/2020/12/OneClimateFuture_VulnerabilityAssessment_Final.pdf

Existing Social Vulnerabilities

Due to existing social vulnerabilities, the burden of climate change will not be felt equally across the community. People with existing social vulnerabilities will be disproportionately impacted by climate hazards. Communities with higher populations of at-risk individuals will be less resilient to climate hazards, and have less capacity to prepare for, respond to, or recover from climate events. Using demographic information to identify the populations most vulnerable to climate hazards allows the Town of Freeport to better direct planning and resources when preparing for future climate impacts.

Social Vulnerability refers to factors that may weaken a community's ability to adapt to or recover from a disaster and is an indicator of community resilience. Examples: Age, race, households with no vehicle, financial burden

- **Natural Resource Industry** is defined as those working in agriculture, forestry, fishing and hunting, and mining.
- **Cost burdened** are households who spend 30% or more of their income on housing expenses. Significantly cost-burdened households spend more than half of their income on housing costs.
- **Multi-Unit Structure** is a housing structure with 3 or more units.
- **Crowding** is a household with more people than rooms. This includes owner-occupied and renters.

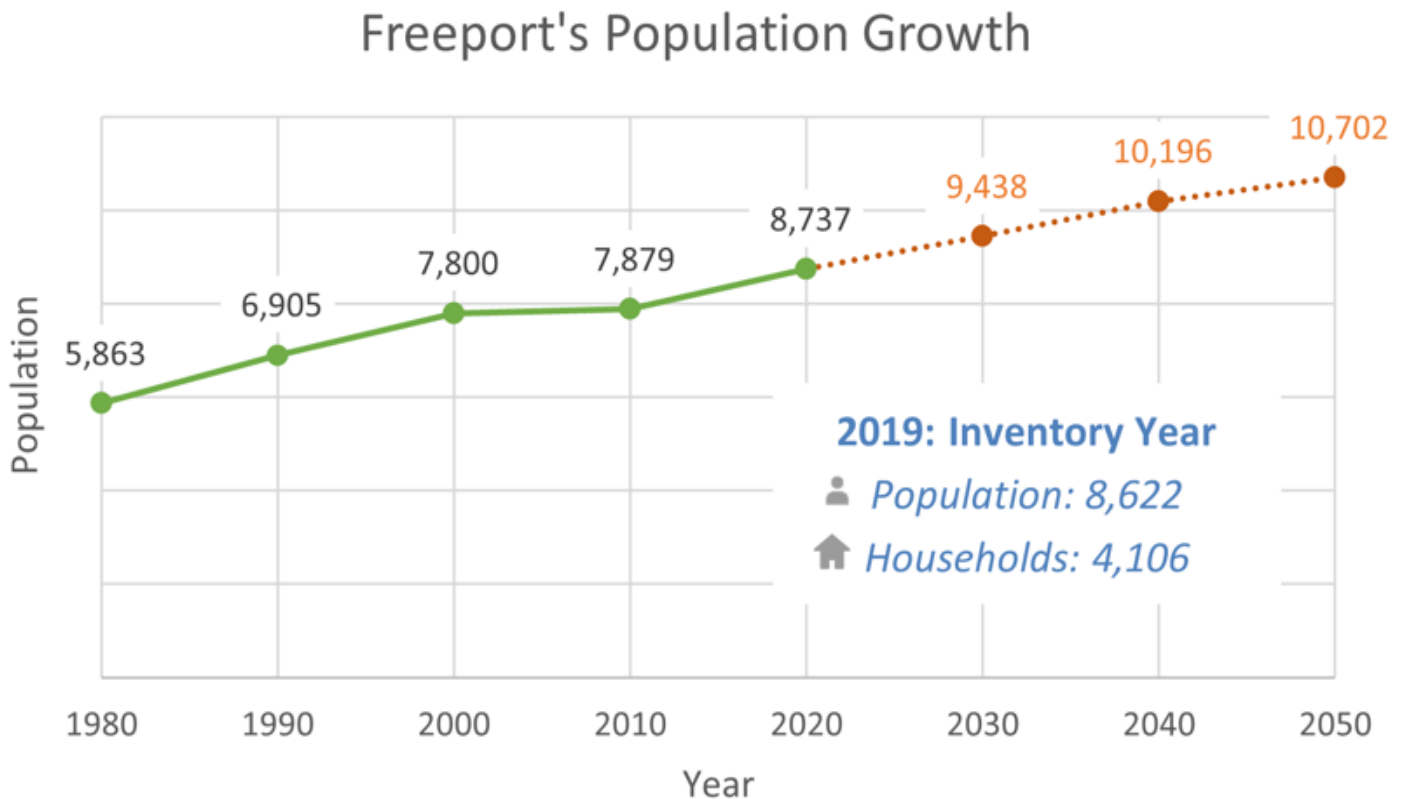


Figure 6: Freeport's population growth for 1980-2020, with projections for 2020-2050 using the historic growth rate of 0.74% annually.

Data

To identify populations with the potential for high social vulnerability, demographic data in this report relies primarily on American Community Survey (ACS) 5-year estimates (2017-2021) from the U.S. Census Bureau. Variability across Freeport was analyzed at the block group level, which is the smallest geographic unit available. Unfortunately, all data is inherently flawed and has limitations. However, this analysis still provides Freeport with baseline information and the ability to assess social needs across town.

The Maine Social Vulnerability Index (SVI) developed for the Maine Climate Council identifies 17 social demographic characteristics that contribute to an individual's or household's vulnerability to climate impacts. This assessment looked at each SVI factor along with additional key climate-related metrics to highlight Freeport's social vulnerability.

See Attachment B for more information on the data, limitations, and methodology.

Table 1: Freeport Social Vulnerability Index Characteristics. Source: U.S. Census Bureau

Demographic		Socioeconomic		Housing	
Age 65 or over	2,131 (24.7%)	Below poverty level	513 (6.1%)	Multi-unit structure	446 (10.9%)
Age 65 or over and living alone	412 (4.8%)	Self-employed	613 (17.9%)	Mobile homes	290 (7.1%)
Age 18 or younger	1,828 (21.2%)	No high school diploma	251 (3.9%)	Crowding	22 (0.6%)
People of Color	777 (9.0%)	Unemployed	222 (3.2%)	Single Parent Household	181 (5.3%)
Speaks English less than well	35 (16.3%)	Natural Resource Occupation	36 (0.8%)	Household with no vehicle	74 (5.3%)
Living with a disability	558 (16.3)	Median household income	\$86,870	Renters	673 (19.6%)
		Cost burdened	762 (22.7%)	Older Housing Stock	1,569 (38.2%)

Notes: Calculations for each factor are based on different populations. For example, age and race or ethnicity factors are calculated based on total population while linguistics is determined for total population 5-years-old and older. Housing factors are calculated based on total households or housing units. Please see A lifeline and social vulnerability analysis of sea level rise impacts on rural coastal communities (2018) by Johnson, et. al. for a full description. Data Source: U.S. Census Bureau

Compounding Social Vulnerability

Each individual factor increases a person's vulnerability to climate change; however, many people and households experience multiple factors. The more simultaneous factors someone experiences, the harder it will be to adapt to climate change. For example, an elderly resident living alone may also live in poverty and lack access to a vehicle. Evacuating during a severe storm could be difficult due to decreased mobility, reliance on public transportation, fewer communication channels, and limited financial means.

Key takeaways

Overall Freeport has low social vulnerability. Freeport is more educated and has a higher median household income than Cumberland County or the state of Maine ²⁹.

Demographics. Freeport has a higher median age than Cumberland County. In particular, the town has a larger percentage of residents 65 years and over. However, the town also has a higher percentage of residents under the age of 18. Both of these populations have a higher risk of heat-related health impacts and are more reliant on others for assistance during a disaster.

Lack of affordability. The town has a high rate of renters who are cost burdened—those who spend more than 30% of their income on housing expenses. This lack of affordability limits residents' ability to respond to and recover from climate events.

Building stock. Freeport also has a high percentage of older buildings. With almost 40% of households built before 1970, many houses may lack energy efficient upgrades and be more susceptible to damage during storms.

Despite Freeport's low social vulnerability, there are still geographic regions in town that are more at risk than others. Overall, the downtown area contains the most at-risk populations due to the higher percentage of elderly residents and those who are cost-burdened. Future actions should consider how resources are distributed across the Town to reach the people most at risk.

*Table 2: Freeport social characteristics versus Cumberland County.
Source: U.S. Census Bureau*

Factor	Freeport	Cumberland County
Median Age	47.7	41.9
65 years and over	25%	19%
75 years and over	7%	7%
Under 18 years	21%	19%
Homeowners who are cost burdened	46%	44%
Housholds below poverty status	9%	9%
Median building age	1976	1974

²⁹ <https://dashboards.mysidewalk.com/gpcog/freeport>

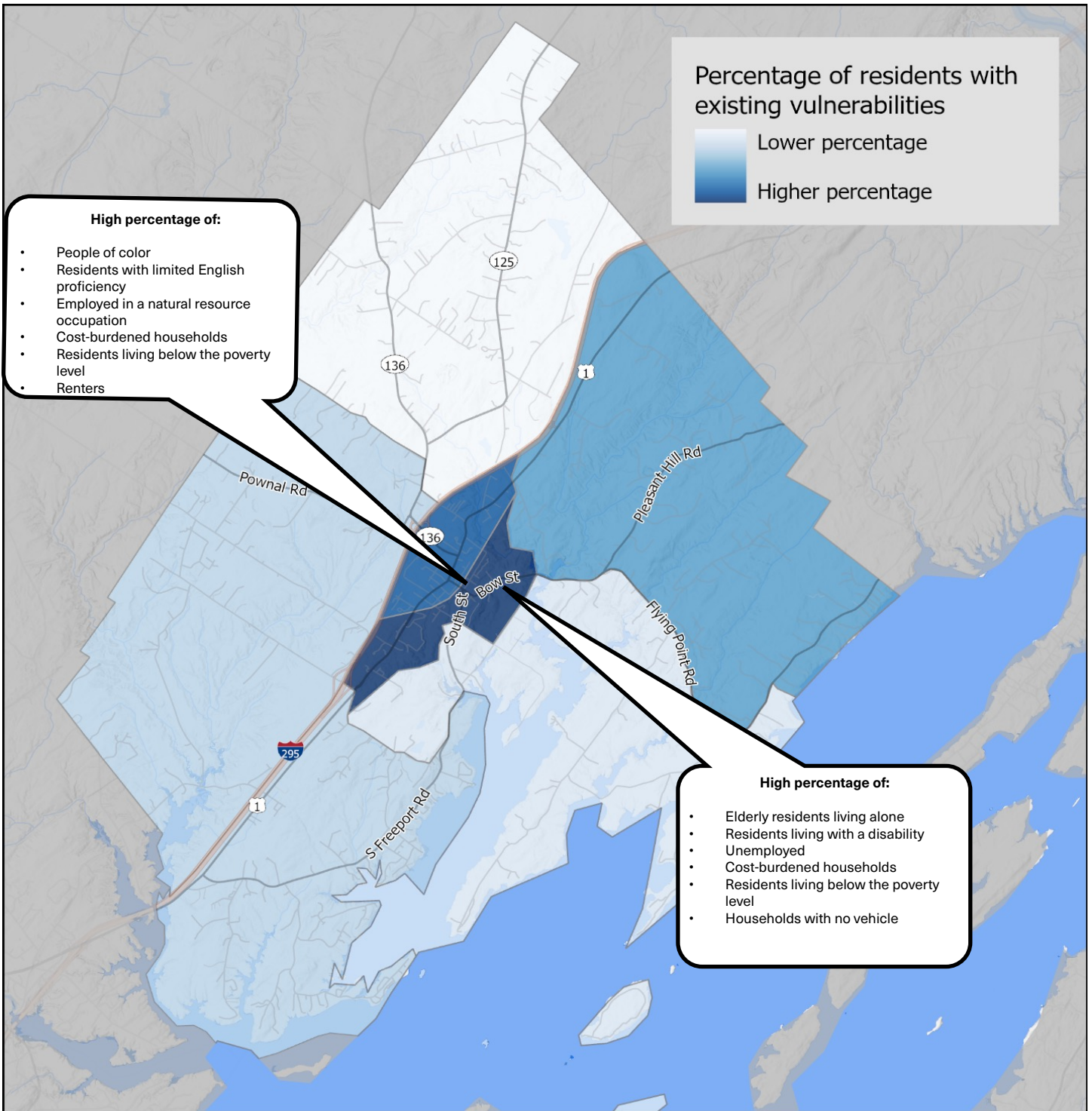


Figure 7: Overall social vulnerabilities in Freeport by census block groups. Darker shades represent a higher percentage of vulnerable populations. Source: U.S. Census Bureau

Demographics

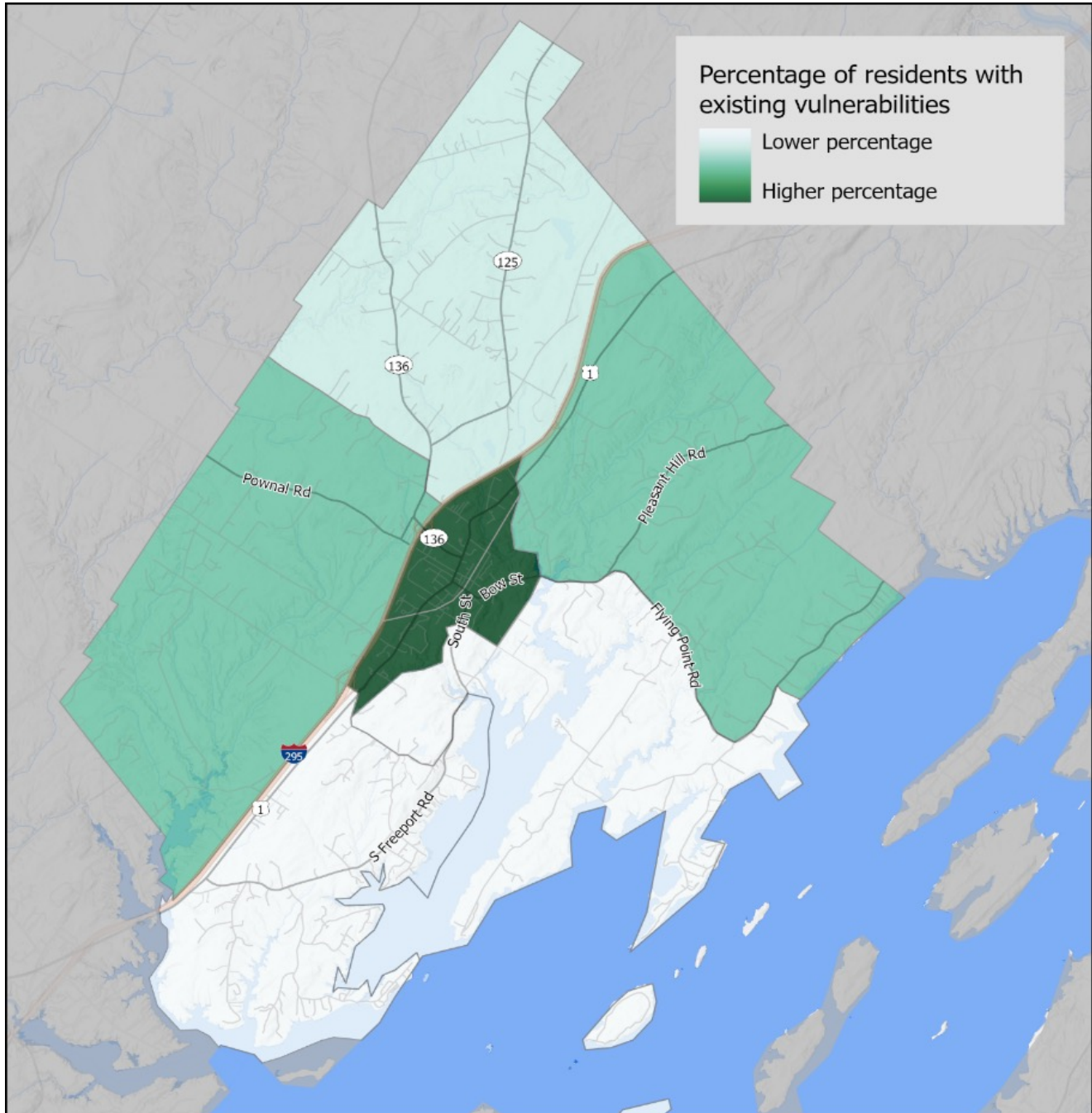


Figure 8: Demographic vulnerabilities in Freeport by census block groups. Darker shades represent a higher percentage of vulnerable populations. Source: U.S. Census Bureau

People identified by the ACS as having a disability are those who report having serious difficulty with specific functions. The survey uses follow-up questions to capture six aspects of disability– hearing, vision, cognition, ambulation, self-care, and independent living.

Age	
<ul style="list-style-type: none"> • 21% of Freeport's population is under 18 • 25% of Freeport's population is over the age of 65 • Over 20% of adults who are 65 and over live alone. That is almost 5% of the total population 	<p>WHY THIS MATTERS</p> <p>Older and younger populations are more at risk for impacts from extreme heat and cold and often have weakened immune systems which makes them more prone to health-related climate impacts. Also, both populations are more likely to rely on caregivers for basic needs.</p>
Health and Disability	
<ul style="list-style-type: none"> • 16% of households in Freeport have someone living with a disability 	<p>WHY THIS MATTERS</p> <p>Residents experiencing poor health or a lack of access to health care will be inherently more susceptible to dangers such as high heat, worsening air quality, and power outages caused by intense storms. The social marginalization of people with disabilities further increases the threat of isolation during a climate-related event</p>
Language, Race, and Ethnicity	
<ul style="list-style-type: none"> • 9% of the population are People of Color • Approximately 1% of the population speak English less than well 	<p>WHY THIS MATTERS</p> <p>Race and ethnicity are strongly correlated with disparities in health, exposure to environmental pollution, and vulnerability to natural hazards. Due to historic and institutional racism, communities of color tend to have multiple socioeconomic factors that make them more susceptible to climate impacts. People who are linguistically isolated or have limited English proficiency may be less likely to hear about upcoming events/emergencies or have challenges communicating their needs during an emergency</p>

Socioeconomic

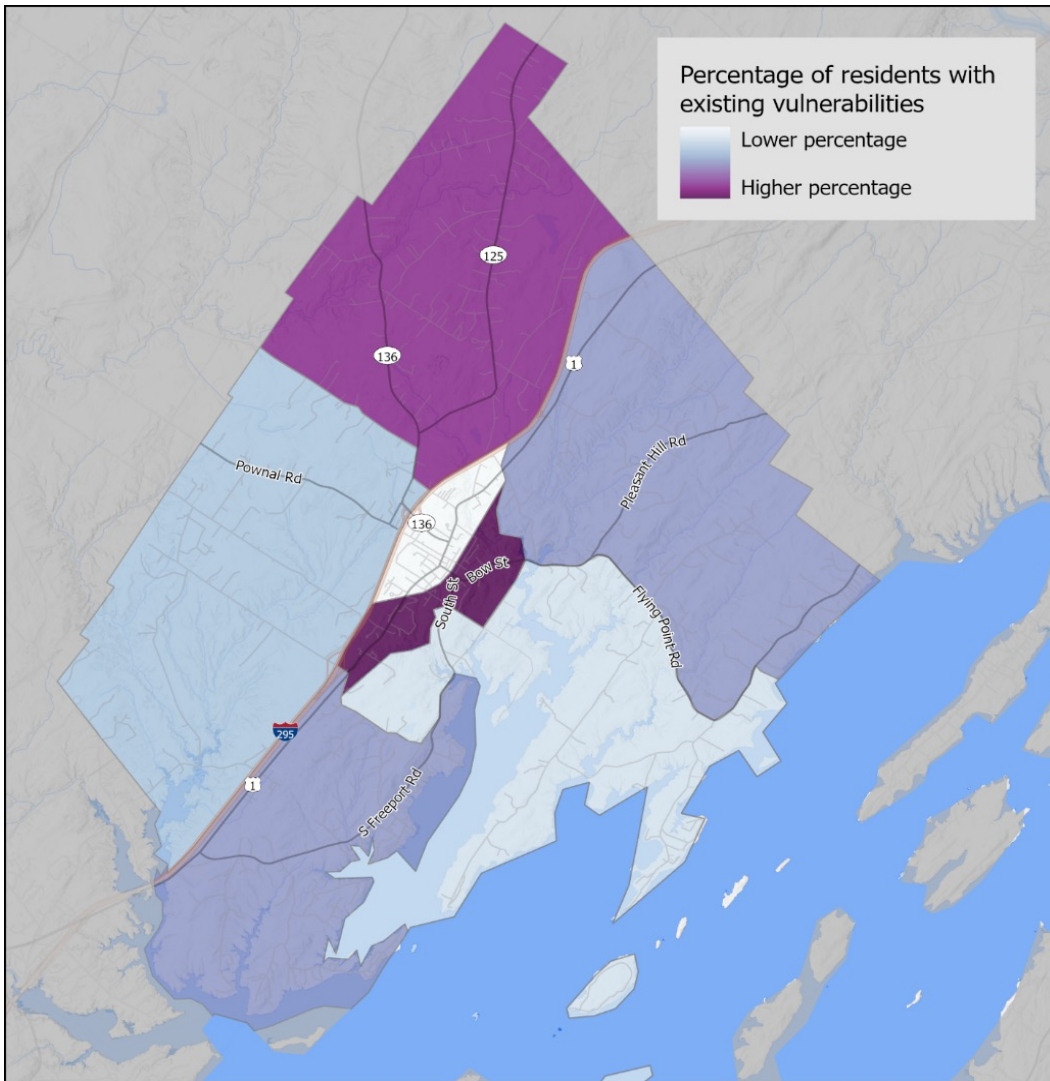


Figure 9: Socioeconomic vulnerabilities in Freeport by census block groups. Darker shades represent a higher percentage of vulnerable populations. Source: U.S. Census Bureau

Financial Insecurity	
<ul style="list-style-type: none"> 6% of the population is living below the federal poverty line 23% of total households are cost burdened. 16% of homeowners are cost burdened while 46% of renters are cost burdened 	WHY THIS MATTERS Financially insecure households are less likely to have property insurance or savings for added or unexpected expenses such as higher energy or food costs, are unable to repair property damage from flooding or severe storms, purchase air conditioning, upgrade to energy efficient appliances (i.e., rooftop solar panels or heat pumps), or evacuate or relocate in case of a disaster.
Employment	
<ul style="list-style-type: none"> 3% of the working age population is unemployed Approximately 1% of Freeport's population works in a natural resource occupation 	WHY THIS MATTERS Added expenses of climate change –such as increasing energy costs or repairs due to storm damage—are particularly detrimental for seasonal workers, those living on a fixed income, and the unemployed. Individuals who are unemployed will also have a harder time relocating in case of a climate disaster. The natural resource industry is particularly vulnerable to the shifts in ecosystems and changing terrestrial and marine conditions that put pressure on job security.

Housing

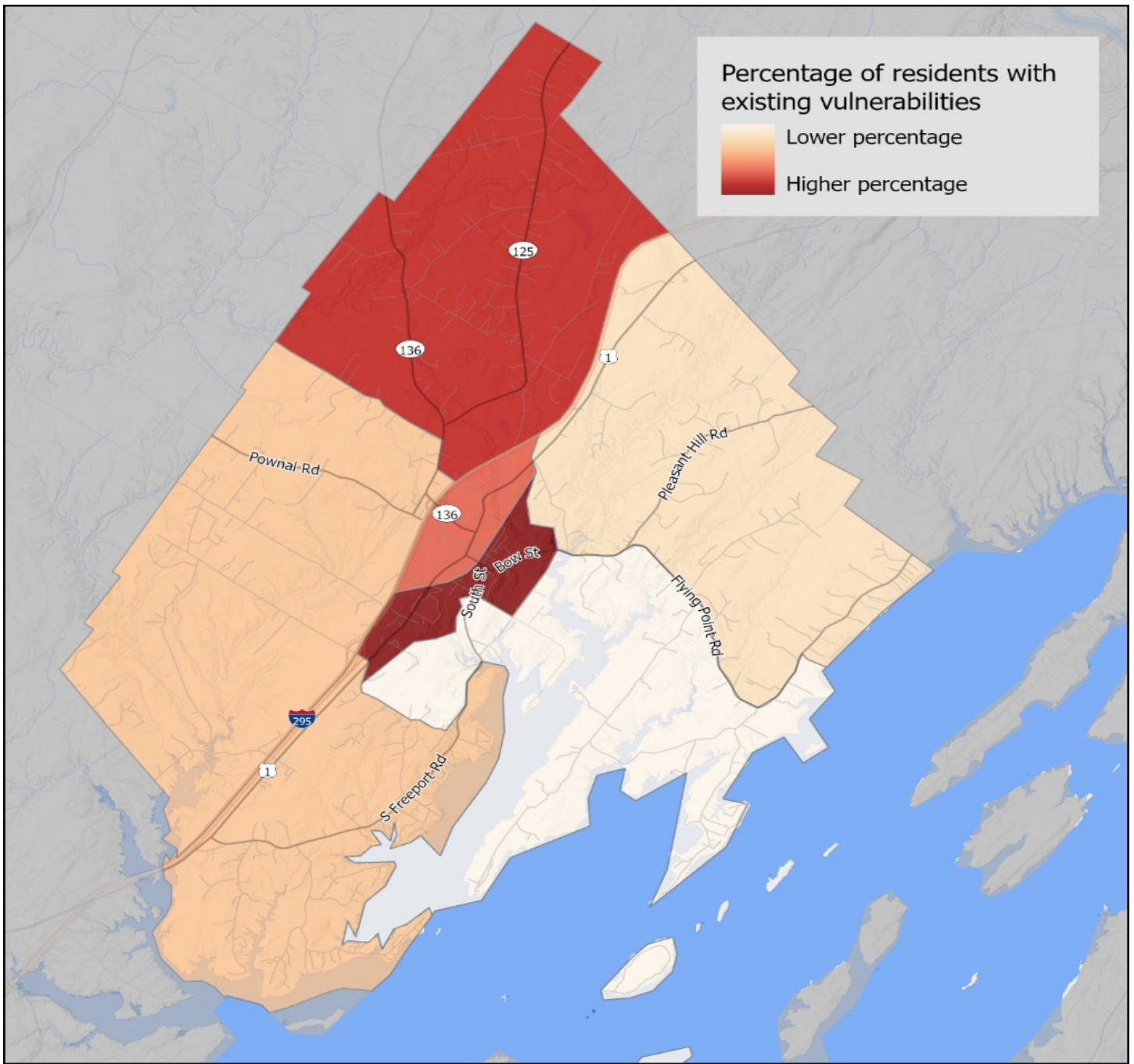


Figure 10: Housing vulnerabilities in Freeport by census block groups. Darker shades represent a higher percentage of vulnerable populations. Source: U.S. Census Bureau

Access to Internet	
<ul style="list-style-type: none"> 5% of households have no internet subscription. Some households may elect not to have internet even if it is available. 	<p>WHY THIS MATTERS</p> <p>Lack of access to key resources, such as broadband, limits a household's ability to communicate, respond, and recover during a climate crisis. Without access to technology, communities miss crucial warnings, evacuation notices, and other disaster-related information.</p>
Renters	
<ul style="list-style-type: none"> 20% of housing in Freeport is occupied by renters 	<p>WHY THIS MATTERS</p> <p>Renters have far less freedom in preparing for climate hazards than homeowners, as major renovations or upgrades are ultimately decided by the property owner. Sometimes rental properties are not as well maintained and less likely to be retrofitted or weatherized. Renters, especially those who are low- or moderate-income would be less adaptable to climate disasters and would have a harder time finding new housing. Additionally, renters are also often newer to the community and may have less knowledge of local hazards and be less connected to available resources.</p>
Older Housing Stock	
<ul style="list-style-type: none"> 38% of houses in Freeport were built before 1970 	<p>WHY THIS MATTERS</p> <p>Older buildings are often less energy efficient, both for keeping warm in the winter and cool in the summer, costing residents more money on heating/cooling and exposing them to more extreme temperatures. In addition, houses built before 1970 were constructed prior to modern building codes, such as smoke alarms, that help reduce risk.</p>

Home Heating

The source of heating for a house has an impact on both greenhouse gas emissions and vulnerability. Fuel oil, kerosene, propane, and natural gas all release carbon dioxide into the atmosphere. The cost of fuel varies by heating source and places further stress on financially insecure households³⁰. Heating (or cooling) the home using electricity provides a more cost-effective, sustainable solution to help combat climate change. However, electrification must be paired with grid upgrades and resilience measures to ensure that the electrical grid can withstand increased consumption and remain resilient against climate hazards.

In Freeport

Half of Freeport homes are heated by fuel oil³¹. This is both one of the more costly heating sources and a greater emitter of greenhouse gases. Conversion away from oil will both reduce emissions and increase resiliency for the residents.

Table 3: Home heating fuel sources in Freeport in 2021

Source: U.S. Census Bureau

Heating Fuel	Number of households (%)
Natural Gas	251 (7.3%)
Propane	784 (22.9%)
Electricity	257 (7.5%)
Fuel Oil or Kerosene	1,729 (50.5%)
Wood	249 (7.3%)
Solar Energy	149 (4.3%)
Other Fuel	8 (0.2%)

³⁰ <https://www.maine.gov/energy/heating-fuel-prices>

³¹ The U.S. Census does not differentiate between kerosene and fuel oil use. Most homes in this category likely use fuel oil.

Risks to Critical Infrastructure

Climate hazards cause damage to critical infrastructure such as roads, buildings, and utilities. Today’s infrastructure was not built to withstand the types of extreme climate events we currently experience or conditions we expect in the future. Although a 100-year storm has a low percent chance of occurring in any given year, the most valuable infrastructure and access to neighborhoods needs to be protected given the potential impacts. Below is a summary of the potential climate hazards and resulting impacts on Freeport’s critical infrastructure.

Key Takeaways

Overview	Freeport’s critical infrastructure is relatively protected from flooding. The biggest risk to infrastructure is flooding that cuts off access to residences due to limited connected streets. Those living along the peninsula by Winslow Memorial Park are most at risk of losing access during a storm event.
Transportation	Flooded roadways will disrupt transportation, limit transit, and impact access to community resources throughout town. Waterfront infrastructure, including docks, marinas, and access points, are at risk of flooding and erosion in some areas with coastal bluffs.
Wastewater, Stormwater, and Drinking Water	Freeport’s water systems are relatively resilient to climate change impacts. There is limited infrastructure in flooded areas; however, the data available for this report was also limited and more analysis may be needed.
Buildings	Overall, there are relatively few buildings at risk. Residential buildings are most at risk of flooding, however, these are dispersed throughout town due to the large number of streams and brooks.
Power and Information	Power, communication, and energy infrastructure are most at risk from high winds from severe storms.
Geographic areas of concern	<ul style="list-style-type: none"> • Winslow Memorial Park Peninsula – This area provides important recreational areas as well as a radio communication site. In the case of a flooding event the one road access to the peninsula will strand residents. • Downtown – The area contains the largest concentration of infrastructure including stormwater systems, municipal resources, and community resources such as Freeport Community Services. Maintaining access to this area will be critical to ensuring resilience during a hazard event.

Transportation

Transportation infrastructure is at risk of flooding from a combination of sea level rise, increased levels of storm surge, and increased precipitation. It is not just coastal roadways and bridges that are at risk but inland infrastructure as well. Increased intensity of storms leads to erosion and damage to infrastructure, disruption in transportation services, and increased maintenance and repair costs.

Vulnerable Assets in Freeport

Jurisdiction over the roads varies between MaineDOT, the Town of Freeport, and private owners. Modeling shows that in 2050, approximately 6 miles of roadway would experience some degree of flooding during a 100-year storm event.

Table 4: Transportation infrastructure in Freeport that is vulnerable to flooding based on projected 2050 100-year flood, 1.6 ft of sea level rise, and 3.9 feet of sea level rise. Inundation is determined by sea level plus highest astronomical tide (HAT)

	1.6 ft SLR	3.9 ft SLR	100-year flood
Roads	US Route 1, I-295 plus 5 local or neighborhood roads	US Route 1, I-295, S Freeport Road, plus 8 local or neighborhood roads	US Route 1, I-295, S Freeport Road, South St, St Route 136, Pownal Rd, Durham Rd, Flying Point Rd, St Route 125, Bow St, Wardtown Rd, plus over 100 local or neighborhood roads
Bridges	None	None	Durham Rd and I-125
Rail	None	None	CSX Rail line
Transit	None	None	Metro Breeze, Amtrak Downeaster
Marinas and Docks	All public and private marine infrastructure is at risk		
Culverts	Flying Point Road across Little River, Staples Point Road across Lambert Point Stream, Across the CSX railway close to the border with Yarmouth, Main Street across Forest Gully Brook		

Roads and Bridges

By 2050, climate change threatens to bring increased chances of flooding to major local and state roadways and bridges within Freeport. This includes portions of I-295 and US Route 1, which are managed by Maine DOT. In addition, local corridors are vulnerable to flooding due to increased precipitation and severity of storms, cutting off neighborhoods.

- Potentially flooded roads during a storm event are not concentrated to one area but are spread out around town due to the number of streams and brooks that can swell with precipitation. This could make it challenging to navigate around town during a flooding event as roads could be flooded across multiple areas.
- Those living along the peninsula by Winslow Memorial Park are most at risk during a storm event. This would make emergency access or evacuation difficult. Sea level rise also threatens to inundate and damage bridges in Freeport.
- The neighborhoods along Route 125 by Collins Brook and Florida Lake have higher vulnerability to flooding and lower ability to adapt due to the limited number of connector roads to get to or from the neighborhood.
- Due to Freeport's road network, the majority of flooded roads are neighborhood streets that are dead ends and not connected. This will make it particularly difficult to evacuate during flooding events or for emergency access.
- Bridge elevations should be assessed in greater detail to ensure future flooding does not cut off access.

The MaineDOT Environmental Office developed a risk evaluation tool, Transportation Risk Assessment for Planning and Project Delivery (TRAPPD), to assess bridges and large culverts based on a set of 12 questions with criteria that span the range of risks including budget, process, schedule, events, and safety. Scoring is applied based on a summation of the questions and is used along with asset condition and performance to evaluate the overall priority and risk associated with the asset ³². Of the 16 bridges in Freeport assessed as part of the program in 2018, only 2 bridges were classified into the highest risk category and 11 were medium risk. The bridges with the highest risk were I-295 northbound and southbound across Cousin's River.

³² <https://www.maine.gov/mdot/publications/docs/plansreports/MaineDOT-Transportation-Asset-Management-Plan-final.pdf>

Hazards and Impacts



Precipitation and Flooding

- Temporary inundation
- Disruption to services
- Increased degradation and erosion
- Increased chance of damage from intense storms
- Larger amounts of runoff and sediment



Sea Level Rise

- Temporary and permanent loss of infrastructure
- Risk of damage and erosion



Warming Temperatures

- Bucling, cracking, and softening of road pavement due to warmer temperatures will shorten the lifespan of the infrastructure and create poor driving



People and Community

- Access to key neighborhoods, businesses, and key community assets are cut off. This can stand residents and prevent emergency vehicle access



Economic

- Increased costs for maintenance and repair. Emergency repairs, retrofitting culverts to appropriate sizing, and more frequent paving or replacement due to shorter lifespans will cost the town money
- Disruptions to supply chains caused by flooded infrastructure will harm the local economy



Natural Resources

- Undersized or degraded culverts create barriers for habitat migration

Railways

A railway owned by CSX Transportation runs through Freeport. Portions of the railway, particularly around tributaries to the Cousin's River, are vulnerable to flooding in 2050 in a 100-year storm. Further analysis should be completed to ensure bridge height would exceed expected flooding levels. This railway is also used by the Amtrak Downeaster (see below). Further analysis should be completed to ensure bridge height would exceed expected flooding levels.

Transit

The Metro Breez runs along Main Street/US Route 1 through Freeport with stops at Maine Beer/Park & Ride, LL Bean Headquarters, Town Hall, and LL Bean Flagship Store. Metro Breez is an express bus service running between Portland and Brunswick with more than a dozen daily round trips Monday through Friday and five trips on Saturday.

In 2050, portions of Main Street/Route 1 within Freeport are vulnerable to flooding during a storm event. This would limit access and reduce mobility for those who rely on the transit service.

The Amtrak Downeaster has a station in Freeport. The Downeaster makes five round-trips daily between Brunswick, Maine and Boston, Massachusetts. The Downeaster service is operated by Amtrak with financial support from The Northern New England Passenger Rail Authority. As mentioned above, portions of the rail line are at risk of flooding during a severe flood event. This could disrupt service and hinder those who rely on the Downeaster for travel and commuting.

Marinas and Harbors

Freeport has numerous moorings, supporting commercial and recreational boats. All of Freeport's private marinas as well as its Town Landing, are vulnerable to sea level rise and flooding which would limit access for commercial fishing and recreational boaters. Sea level rise could cut off ramp access for boats to enter and exit the water during sunny day high tides. Freeport has already received a Shore and Harbor Grant from the State of Maine to further assess the vulnerability of Town Landing and the potential to move the landing to protect it from future sea level rise.

Harbor floats can withstand winds of 45 mph, but faster wind speeds from increased severity of storms could impact infrastructure, temporarily flood boat launch areas, and cut off access for marine vessels to return to shore.

Culverts

The Nature Conservancy developed an analysis of culverts at risk of overtopping in a flood. This analysis shows three culverts in Freeport have a high risk of overtopping. One additional large culvert assessed using MaineDOT's Trappd Score was classified as the highest risk.

- Flying Point Road across Little River (Nature Conservancy)
- Staples Point Road across Lambert Point Stream (Nature Conservancy)
- Across the CSX railway close to the border with Yarmouth (Nature Conservancy)
- Main Street across Forest Gully Brook (MaineDOT)

These culverts should be examined and potentially improved. A more extensive culvert study should be conducted to assess the capacity of smaller culverts.

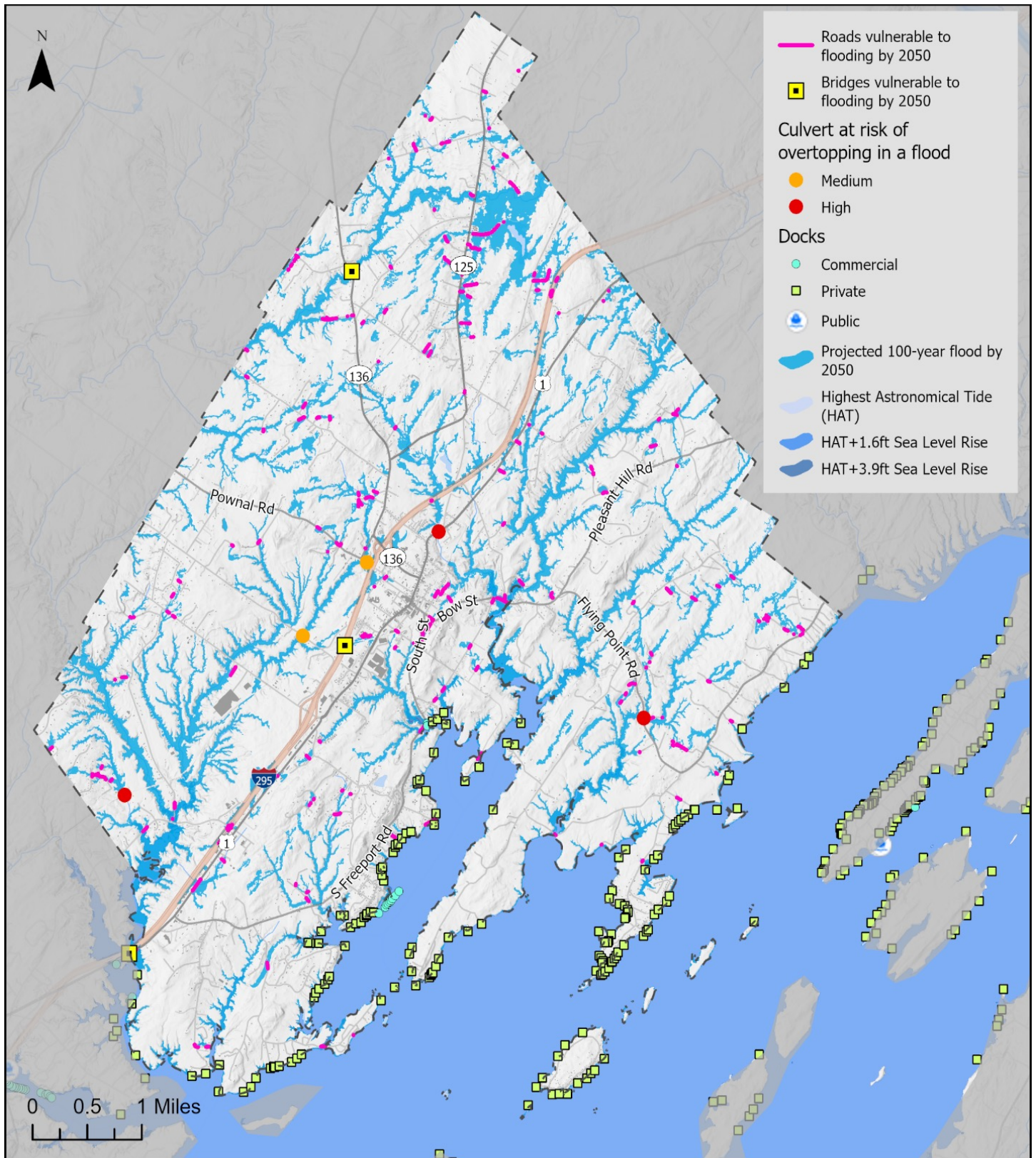


Figure 11: Transportation infrastructure at risk of flooding by sea level rise or 100-year storms by 2050. Source: Town of Freeport, Maine Geological Survey, MaineDOT, Maine DEP, FloodFactor

Wastewater, Stormwater, and Drinking Water

Sea level rise, increased precipitation, and increased flooding severity pose new risks to the daily operation and structural integrity of water systems—wastewater, stormwater, and drinking water.

Pump stations in low elevation areas may become inundated during intense precipitation events that flood an area faster than a station can pump out. This will temporarily flood nearby roadways and risk wastewater contaminating streams and waterways. Once the storm is over, a pump station will be able to pump any remaining overflow water without threatening the capacity of the Town's piping network.

Flooding or debris from intense storms could cut off access to infrastructure for repairs or inspections. Inundated infrastructure will have reduced capacity to convey flow, creating the possibility of overflows and threats to water quality. Increasing strain on pipelines may increase leaks and create overflows into waterways, directly contaminating waterways with untreated sewage or contaminated stormwater. Overwhelmed management systems lead to backups that cause localized flooding³³.

Failure and/or damage to these systems could degrade water quality and impact public health (see Natural Resource – Water Quality for more information). Any disruptions to the water systems could further impact residents and business owners.

Wastewater in Freeport

Sewage for the town is operated by the Freeport Sewer District. This is a quasi-municipal corporation with a separately elected Board of Trustees. It was established in 1948 for the purpose of providing and maintaining a sewer system for the collection, treatment and disposal of sewage. Wastewater infrastructure, including pipelines, pumps stations, and manholes were not available for this report.

- Future analysis should look at how specific wastewater infrastructure may be vulnerable to flooding and climate change impacts.
- Freeport has a wastewater treatment facility along S Freeport Road. This facility is not expected to be impacted by sea level rise or flooding from 100-year flood events.

Hazards and Impacts



Precipitation and Flooding

- Lack of access to infrastructure for service and repair
- Increased chance of damage from intense storms
- Inundate and overwhelm system
- Higher runoff and sediment overflow in systems



Sea Level Rise

- Temporary and permanent loss of infrastructure
- Risk of damage and erosion
- Groundwater infiltration



People and Community

- Impacts to public health from a decline in water quality



Economic

- Increased costs for maintenance and repair



Natural Resources

- Increased contaminants in water bodies
- Impacts to ecosystems from decline in water bodies

33 <https://www.epa.gov/arc-x/climate-adaptation-and-stormwater-runoff>

Stormwater in Freeport

Freeport maintains a Stormwater Management Plan and is subject to the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4s) which is issued by the Maine Department of Environmental Protection (DEP). The most recent permit went into effect in 2022 and is approved for five years.

- Flooding will have minimal impact on the inventoried wastewater system. Of the almost 13 miles of stormwater infrastructure mapped, only a mile is in flooded areas, and only 25 of the almost 550 catch basins are in flooded areas.
- Culverts will need to be assessed in future studies to better assess how well the system can handle a 100-year flood event.
- Twenty-six of the catch basins are listed as poor condition.
- Pipelines in flooded areas, especially those in areas impacted by sea level rise, could see increased pressure and deterioration.

Table 5: Stormwater infrastructure in Freeport that is vulnerable to flooding based on different flooding scenarios.

Asset	1.6 ft SLR	3.9 ft SLR	100-year flood
Miles of drainage pipeline in flooded areas	0.05	0.1	1
Drain catch basins	4	6	25

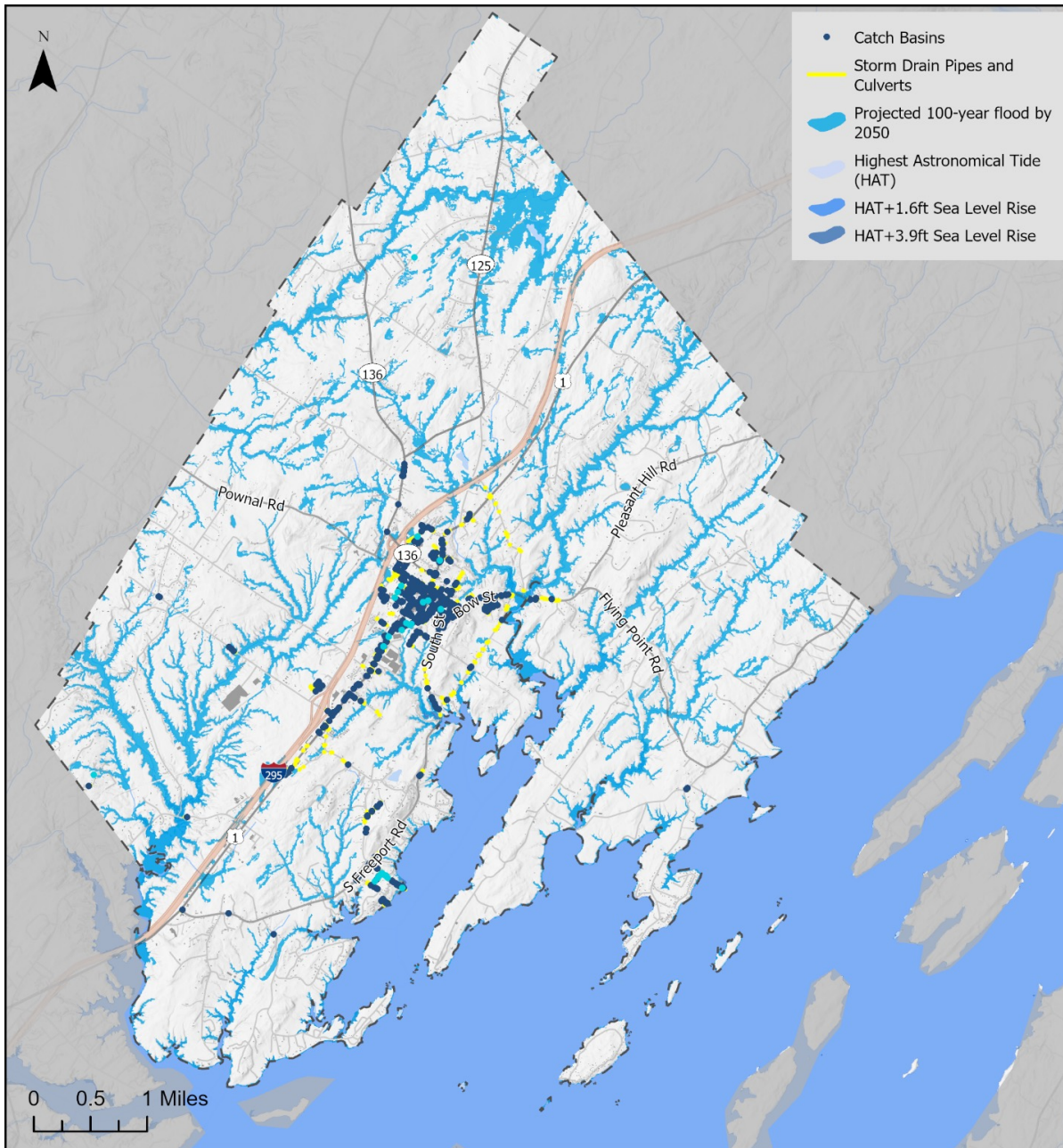


Figure 12: Stormwater infrastructure at risk of flooding by sea level rise or 100-year storms by 2050. Source: Town of Freeport, Maine Geological Survey, FloodFactor

Drinking Water in Freeport

Drinking water in Freeport is managed by the Maine Water Company (Freeport Water District) and South Freeport Water District. Both Maine Water Company and South Freeport Water District use groundwater as the primary drinking water supply. Both districts maintain the pipes and drinking water infrastructure throughout town. There are two interconnections between the districts to provide emergency assistance in the event of major problems.

Data on drinking water networks is protected for safety. Therefore, the locations of drinking water infrastructure are not displayed for this report. However, the Maine Water Company provided information on their system. Only 4 of the 242 water hydrants are located in flooded areas, 1 of which is impacted by sea level rise, and less than 1 mile of pipeline are in flooded areas.

Buildings

Homes, businesses, and municipal buildings are directly impacted by increasing precipitation and heavy storms. Those along the coast risk flooding from sea level rise and storm surges. Older housing stock are especially susceptible to damage and higher energy costs if they have not been properly maintained or retrofitted for energy efficiency. As climate change intensifies, residents in the Town of Freeport will see increased property damage. For more information on the economic impact from building and property damage see Vulnerable Community Assets section.

Vulnerable Assets in Freeport

According to analysis, almost 2,000 parcels in the town may experience at least a minor degree of flooding during a 100-year storm, however, most would not impact structures on the property. Flood Factor analysis predicts 112 buildings could experience flooding by 2050 during a storm event, and up to 13 buildings could be impacted by sea level rise. Impacted buildings are in flooding zones along streams and tributaries spread out around town and not concentrated to one area. According to Risk Factor, there are 17 properties in Freeport that have greater than a 26% chance of being severely affected by flooding over the next 30 years³⁴. This represents 4% of all properties in Freeport.

More buildings in town may be damaged by strong storms or high winds, however, these impacts are harder to project at a local scale and cannot be assessed through this report. Older buildings or buildings which have not been upkept are most at risk of damage from severe storms.

Hazards and Impacts

- 

Precipitation and Flooding

 - Damage from flooding and extreme weather
 - Temporary inundation
- 

Sea Level Rise

 - Temporary and permanent loss of property
- 

Warming Temperatures

 - Increased energy costs
- 

People and Community

 - Strain on community resources and services
 - Decline in public health
- 

Economic

 - Changes in property value
 - Increased costs for repair, maintenance, and retrofits

Several key properties impacted by projected climate scenarios include:

Table 6: Buildings in Freeport that are vulnerable to flooding based on different flooding scenarios

Asset	1.6 ft SLR	3.9 ft SLR	100-year flood
Buildings Impacted	7	13	112
Parcels Impacted	582	614	1,931

³⁴ https://riskfactor.com/city/freeport-me/2326490_fsid/flood

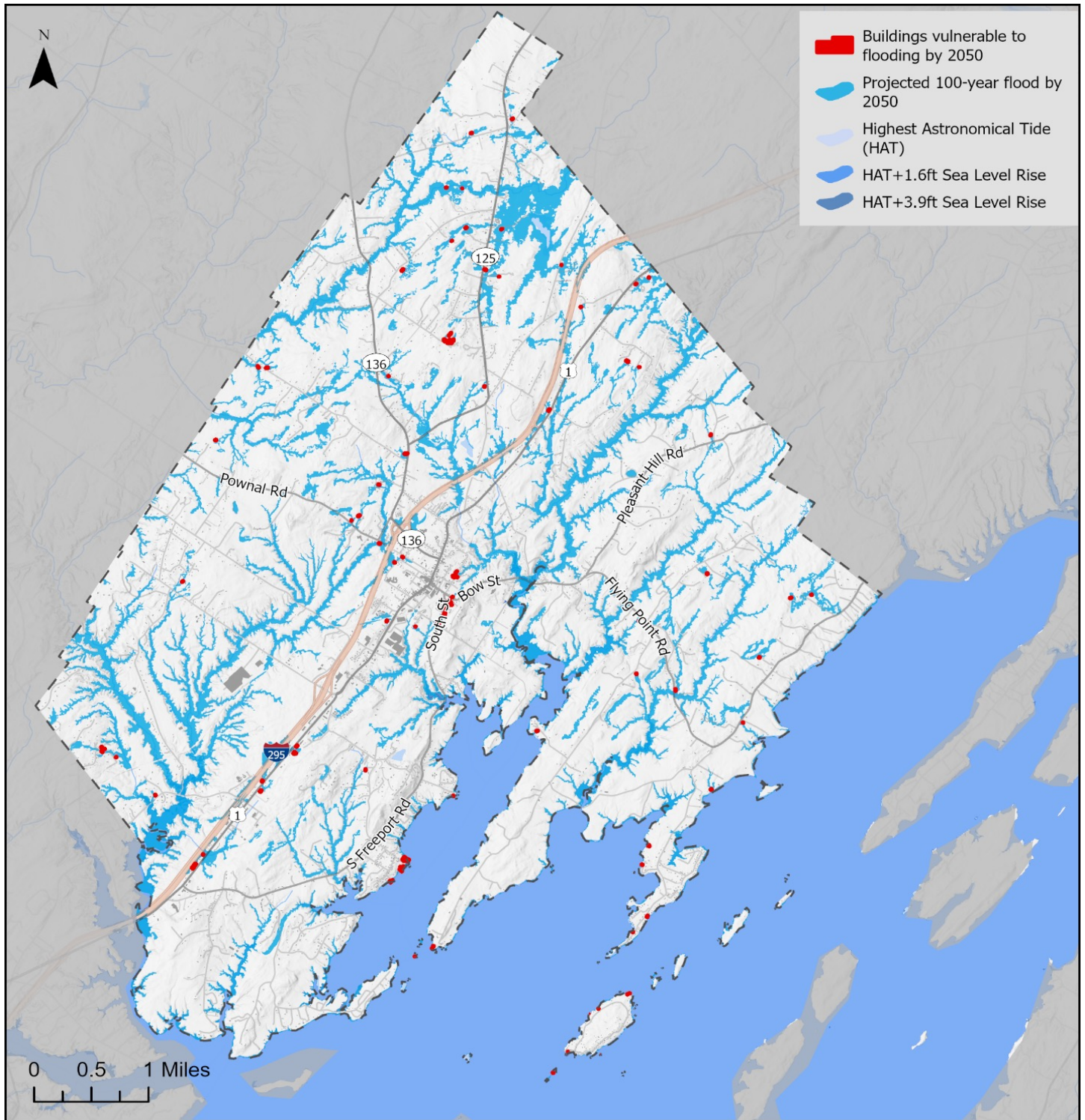


Figure 13: Building at risk of flooding by sea level rise or 100-year storms by 2050. Source: Town of Freeport, Maine Geological Survey, FloodFactor

Power and Information

Energy and information systems, including radio towers, data centers, substations, transmission and cable lines, are growing increasingly vulnerable to climate change, with both direct and indirect impacts threatening the efficiency of the system and the reliability of supply. Faster wind speeds, heavier precipitation events and storm surges, and flooding will increasingly disrupt transmission lines, inundate substations and data centers, and erode communications systems.

Indirectly, the projected temperature changes may shift patterns in energy use, causing strains on both system reliability and capacity. Strain on the energy grid from increased demand or disruptions in equipment due to climate change could create financial burdens on residents, businesses, and the Town. As the intensity and prevalence of heat waves increase, higher demand for air conditioning increases the strain on power lines, increasing the chance of partial power outages and brownouts on high heat days. Through the bipartisan infrastructure law and inflation reduction act, Maine is already investing heavily in grid upgrades to support electrification and ensure reliability.

In Freeport

The energy and communications systems that service Freeport are interconnected within broader regional systems, and most assets are serviced by private utilities which have ultimate jurisdiction over any infrastructure systems. Understanding local infrastructure connections in the context of both the regional systems and climate hazards is necessary to determine potential actions for risk mitigation.

These plans should be included in local emergency management plans.

Freeport has five radio communication sites in town. One, in Winslow Park, is vulnerable to sea level rise. The site in Winslow Park and a cell tower along Route 1 at the north end of town are situated on parcels vulnerable to flooding during a 100-year storm by 2050. This would make access for repair challenging. All of the communication sites are also at risk of damage from high winds or heavy storm events.

See Attachment B for more information on the data, limitations, and methodology.

Vulnerable Community Assets

Climate hazards will have a direct impact on Freeport’s social and economic health. Impacts on housing security, food security, and public health will also lead to economic stressors. As mentioned earlier, climate change will not affect everyone equally; it will be felt most by those most vulnerable. Climate change may even further compound social inequity by amplifying many of the existing vulnerability factors. Being a smaller town, Freeport does not have the same ease of access to various nonprofit and social organizations as larger cities, and thus relies on regional support and collaboration. To account for the most vulnerable populations, Freeport will need to expand support to address heightened social vulnerability from climate change, and to ensure equitable processes and outcomes in future planning for climate resilience.

Key Takeaways

Overview	The biggest concern for Freeport will be access to resources during flooding events. Flooded roads and properties can make navigation difficult and limit the ability to access services and resources.
Public Health	Freeport residents will experience a range of physical, emotional, and mental health impacts. These impacts will be similarly felt across all communities in the greater Portland region. Those with existing social vulnerabilities will be most susceptible.
Community Services	There will be little direct impact to community services in Freeport. However, access to these resources may be limited by flooded roadways. Residents will also need to navigate the increased risks to recreational areas including parks and trails.
Economy and Livelihoods	Freeport’s natural resource economy is most at risk. Rising ocean temperatures and ocean acidification could cost the town’s marine industry thousands of dollars of revenue each year. In addition, flooding will impact the municipal tax base.
Geographic areas of concern	Downtown – this area has a high concentration of community services and resources. In addition, it is an area of high heat severity and puts those most vulnerable at a greater risk of health impacts.

Public Health

Climate change impacts a wide range of public health concerns for both physical and mental wellbeing. For example, extreme heat poses serious health consequences from dehydration to heat stroke. Increased precipitation can contaminate water bodies and reduce water quality. Climate change can affect human health by impacting the severity or frequency of existing health problems, such as asthma and Lyme disease. In this section we will highlight the possible public health impacts that Freeport will need to prepare for.

Air Quality

Climate change will likely exacerbate poor air quality over time, as rising temperatures speed up the chemical reactions that create smog, and changes in wind patterns may potentially reduce local air circulation, trapping pollution at the ground level³⁵. Additionally, Maine is susceptible to pollution from sources located hundreds of miles away. In the summer of 2023, fires in Canada impacted the air quality index in Maine, prompting the state Department of Environmental Protection to issue three separate air quality alerts³⁶. Increasing severity and prevalence of wildfires, in Maine and beyond, increases particle pollution.

Increases in temperature and humidity will influence air pollution, affecting the number of cases and severity of respiratory conditions³⁷. Higher annual temperatures are likely to bring earlier flowering, more pollen production, and the potential for a longer pollen season. Higher levels of pollen, pollution, and particulate matter can cause irritation and infection; trigger allergic responses, asthma, and other respiratory stress; and even cause serious cardiovascular problems such as heart attacks and strokes or lead to chronic respiratory conditions. In 2021, 12.5% of adults in Maine had asthma³⁸. Residents with existing health conditions will be more vulnerable to poor air quality.

In Freeport

There is no specific air quality measurement for Freeport, however, the Environmental Protection Agency (EPA) maintains a monitoring station in Portland for Cumberland County. Overall, Cumberland County has relatively clean air. The EPA's Air Quality Index report is an indicator of overall air quality and takes into account all of the criteria air pollutants measured at the monitoring station³⁹. The graph below shows the number of days where the Air Quality Index experienced unhealthy days. The County has not experienced any "Very Unhealthy" or "Hazardous" days in the last 20 years. Cumberland County has experienced 7 years (2001-2003, 2005, 2007, 2010, 2013) where the 8-hour ozone daily maximum concentration exceeded the National Ambient Air Quality Standard of 0.070 ppm which was set in 2015⁴⁰.

35 U.S. Global Change Research Program. (2016). The Impacts of Climate change on Human Health in the United States: A Scientific Assessment <https://health2016.global-change.gov/>

36 Portland Press Herald. (2021). Smoke from western wildfires affecting air quality throughout Maine.

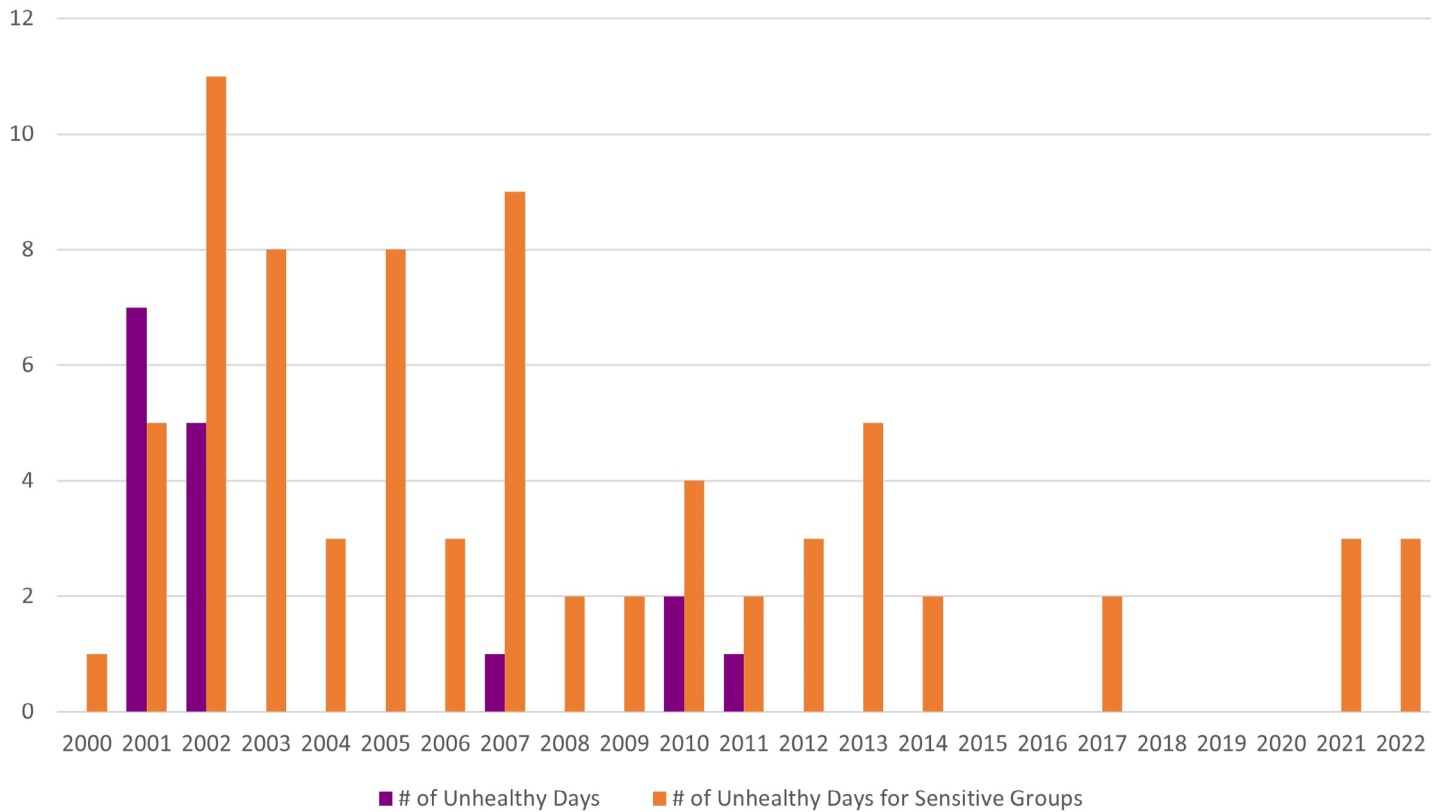
37 <https://onlinelibrary.wiley.com/doi/full/10.1111/all.14177>

38 Centers for Disease Control and Prevention. (2020). Most Recent Asthma State or Territory Data https://www.cdc.gov/asthma/most_recent_data_states.htm

39 <https://www.epa.gov/outdoor-air-quality-data/air-quality-index-report>

40 <https://www.epa.gov/outdoor-air-quality-data/air-quality-statistics-report>

Number of Days with Unhealthy Air Quality



Drinking water quality and supply

Increased precipitation creates more stormwater runoff, which impairs water systems. Stormwater runoff delivers larger quantities of pollutants such as nutrients, sediment, bacteria, and trash into water bodies. These pollutants increase the likelihood of water-related illnesses⁴¹. Combined with higher temperatures, Water quality is further degraded by increase in toxic algal blooms due to higher temperatures.

Sea level rise presents the risk of saltwater intrusion—which is where saline water infiltrates groundwater and freshwater aquifers⁴². Saltwater intrusion contaminates drinking water supplies and can damage underground infrastructure which further leads to degraded water quality⁴³.

Conversely, the extended periods of drought brought on by climate change will deplete groundwater sources⁴⁴. With prolonged periods of droughts and decreased spring snowmelt, groundwater aquifers and wells are at risk of running dry and straining water quantity. In Cumberland County there have been four periods of severe to extreme drought since 2000 (based on the U.S. Drought Monitor). These occurred during the summer and fall of 2001-2002, 2016, 2020, and 2022⁴⁵.

41 <https://health2016.globalchange.gov/>

42 <https://www.epa.gov/arc-x/climate-adaptation-and-saltwater-intrusion>

43 https://www.maine.gov/future/sites/maine.gov/future/files/inline-files/GOPIF_STS_REPORT_092320.pdf

44 Maine's Climate Future 2020 Update

45 <https://www.drought.gov/states/maine/county/cumberland>

In Freeport

As mentioned earlier, households in Freeport receive drinking water through the Maine Water Company (Freeport District) and South Freeport Water District. The 2022 Water Quality Report indicated that drinking water met all national primary drinking water standards for both districts ⁴⁶.

The Maine Drinking Water Program (DWP) evaluates public water supplies as part of the Source Water Assessment Program to assess how likely drinking water sources are to be contaminated by human activities in the future. In 2003, a source water assessment was completed for the Freeport system and indicates a low-to-moderate risk of significant contamination.

Households which rely on private wells for drinking water are specifically at risk for contaminated water quality ⁴⁷. Private wells are not regulated under the Federal Safe Drinking Water Act or state laws which means well owners are responsible for testing and maintaining water quality. According to the Maine Geological Survey, Freeport has approximately 1,360 wells ⁴⁸. These wells are spread around town, however, those located along the coast are most susceptible to saltwater intrusion.

As the Town also relies on groundwater for drinking water supplies, prolonged periods of drought have impacted residents. In 2022, the Maine Drought Task Force documented 95 privately owned wells that reportedly ran dry during the year, the majority of which were in Cumberland, York, Kennebec, Lincoln, and Knox Counties and 97% of these wells were residents ⁴⁹.

The USGS monitors groundwater levels in Cumberland County at a well in Brunswick and a well in North Windham. Since 2000, the lowest recorded groundwater levels occurred in October 2022 at the Brunswick well and October 2016 at the North Windham well, both corresponding with recent severe drought conditions ⁵⁰. This impacts both town water and private well supply.

46 <https://www.mainewater.com/media/msrfakja/frptme0090580.pdf>, https://www.mainewater.com/media/0roeqnv5/sofrpt_me0091480.pdf

47 https://www.maine.gov/future/sites/maine.gov/future/files/inline-files/GOPIF_STS_REPORT_092320.pdf

48 <https://www.maine.gov/dacf/mgs/pubs/digital/well.htm>

49 <https://www.maine.gov/mema/sites/maine.gov/mema/files/inline-files/Drought%20Task%20Force%20Report%2010-06-2022.pdf>

50 <https://waterdata.usgs.gov/me/nwis/current/?type=gw>

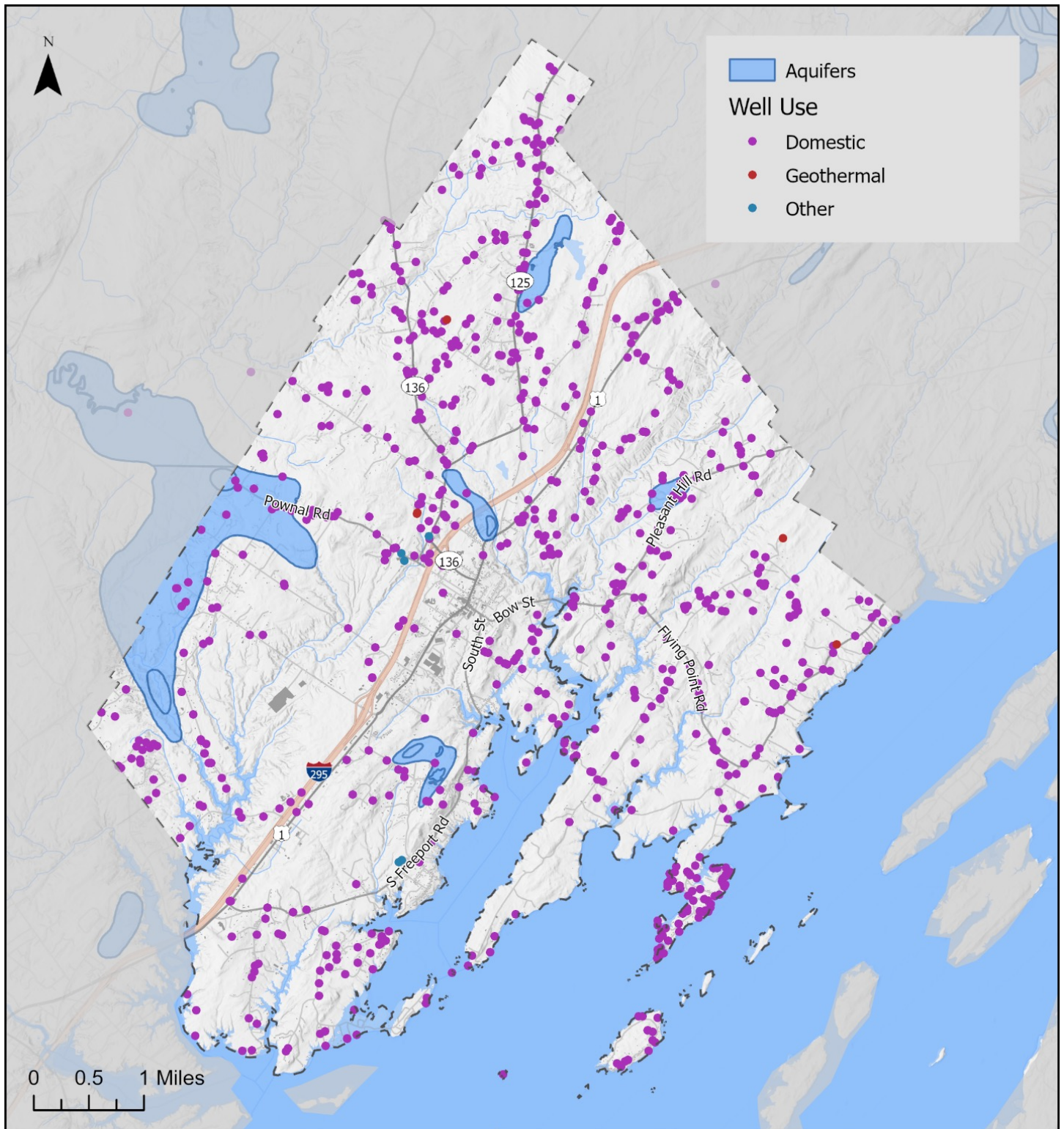


Figure 14: Wells in Freeport. Source: Maine Geological Survey

Vector-borne Diseases

Warmer winters, higher humidity, and more precipitation impact the breeding and survival rates of ticks and mosquitoes, as well as the pathogens they carry. Nine vector-borne diseases (two mosquito-borne and seven tick-borne) have been identified in Maine. In 2021, Lyme disease, which is spread by black-legged ticks or deer ticks, was the most common vector-borne disease in Maine⁵¹. Rates of Lyme disease have increased significantly over the past decades from less than 250 reported cases in 2005 (70 in Cumberland County) to over 2,600 reported cases in 2022 (223 in Cumberland County)- setting a state record⁵². Two other prevalent tickborne diseases – Anaplasmosis and Babesiosis—also had a record number of cases in 2021 with 841 and 201, respectively⁵³.

Vector borne diseases are those passed to humans through non-human vectors, such as mosquitos, ticks, fleas, and bacteria. These vectors pass diseases that are often debilitating and sometimes fatal, and most vector species thrive in high heat and high humidity environments.

In Freeport

Like communities across the state, Freeport is experiencing a prevalence of tickborne diseases. The Maine CDC tracks three diseases at the town level: Lyme, Babesiosis, and Anaplasmosis. Between 2016 and 2020, Freeport had the 4th highest rate of Lyme disease and Babesiosis in Cumberland County, and the 2nd highest rate of Anaplasmosis⁵⁴.

Table 6: Buildings in Freeport that are vulnerable to flooding based on different flooding scenarios

2016-2020	Lyme Disease	Babesiosis	Anaplasmosis
Number of confirmed and probable cases	94	5	39
Rate per 100,000 people	226.4	12	94
Prevalence in Cumberland County out of 28 communities	4th	4th	2nd

Extreme heat

As described earlier, exposure to high heat is linked with a number of health-related concerns. Some populations are at a greater risk of being affected by heat illness, including the elderly, children, individuals with preexisting health conditions, and those who work outside⁵⁵. To combat heat, officials often recommend staying in air-conditioned buildings. However, many Maine homes and businesses lack air conditioning, making people more vulnerable to heat stroke in the summer. Additionally, those with financial and mobility burdens are less able to afford air conditioning or access cooling centers.

To compound this, “heat islands” (areas of town with more impervious surfaces like buildings, roads, parking lots, etc.) retain more heat and have higher surface temperatures. Residents who live or work in high-impervious areas are at greater risk of heat-related illnesses⁵⁶. Areas with more trees and vegetation reduce the effect of heat islands and remain cooler. Historically, the most vulnerable populations within a community have the least access to open, green space.

51 <https://legislature.maine.gov/doc/8753>

52 https://www.maine.gov/DACF/mfs/projects/forestry_fridays/documents/Vectorborne_Tickborne_%20Public%202023.pdf

53 <https://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/lyme/documents/Lyme-Legislative-Report-2022.pdf>

54 <https://data.mainepublichealth.gov/tracking/tickborne>

55 <https://www.maine.gov/dhhs/mecdc/environmental-health/heat/index.html>

56 <https://www.epa.gov/heatislands/climate-change-and-heat-islands>

In Freeport

Based on data from the Trust for Public Land, Freeport only has a small area of land around the downtown that is hotter than the average temperature for the town as a whole from the summer of 2021. The maps show heat severity measured on a scale of 1 to 5, with 1 being a relatively mild heat area (slightly above the mean for the town), and 5 being a severe heat area (significantly above the mean for the town).

In Freeport, the downtown along Main Street extending from roughly Desert Road to Mallet Drive has the highest heat severity. This area is the economic hub for town and has many community resources including Freeport Community Services, town hall, and the library. This area also has higher social vulnerability for residents 65 and older living alone, households who are cost burdened, people of color, renters, and multi-unit buildings.

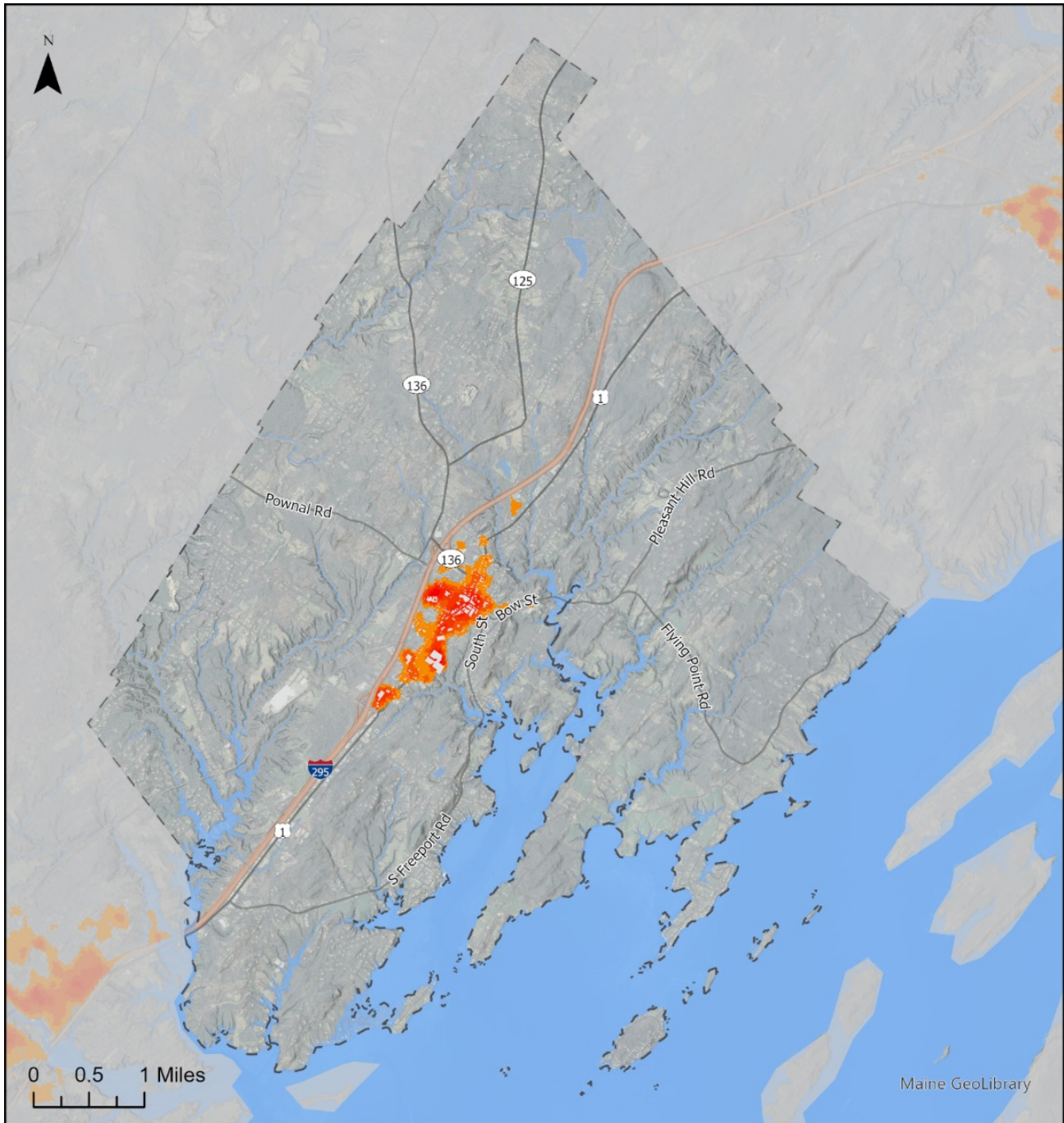


Figure 15: Heat severity in Freeport. Darker areas indicate a severe heat area. Source: The Trust for Public Land

Mental health

Climate change will not only impact people physically, but mentally and emotionally as well. This can include trauma from a climate disaster, stress from changing job industry or increasing financial burdens, or the persistent emotional toll of processing information about climate change⁵⁷. The mental health impacts can be temporary stress from immediate events to long ranging post-traumatic stress disorder, anxiety, and depression. Those who already face social vulnerabilities, described earlier in the report, are more likely to experience adverse mental health outcomes. This includes people who are economically disadvantaged, the elderly, children, first responders, and those which rely on the natural environment for their livelihood⁵⁸. Climate change, specifically extreme heat, will also exacerbate impacts for people who experience mental health conditions.

Further, the mental and emotional stress of climate change interacts with factors, such as relationships or jobs, which further strains social and environmental resilience.

In Freeport

There is no data or information specific to Freeport regarding the impacts of climate change on mental health. However, the Town recently received a grant for a community mental health resource position to share across three neighboring towns.

The Center for Disease Control produces the Behavioral Risk Factor Surveillance System which is a health risk survey aggregated by state that includes questions on mental health. Based on the survey, in 2022 26% of respondents in Maine said they experienced between 1 to 13 days where their mental health was not good, and 16% of Maine respondents said they experienced 14 or more days where their mental health was not good⁵⁹. These percentages have increased every year since 2019.

57 <https://health2016.globalchange.gov>

58 <https://health2016.globalchange.gov>

59 Center for Disease Control BRFSS Prevalence and Trends https://nccd.cdc.gov/BRFSSPrevalence/rdPage.aspx?rdReport=DPH_BRFSS.ExploreByLocation&rdProcessAction=&SaveFileGenerated=1&irbLocationType=States&isLocation=23&isState=&isCounty=&isClass=CLASS20&isTopic=TOPIC71&isYear=2021&hidLocationType=States&hidLocation=23&hidClass=CLASS20&hidTopic=TOPIC71&hidTopicName=Healthy+Days&hidYear=2021&irbShowFootnotes=Show&rdICL-iclIndicators=_PHYS14D%2c_MENT14D&icIndicators_rdExpandedCollapsedHistory=&icIndicators=_PHYS14D%2c_MENT14D&hidPreviouslySelectedIndicators=&DashboardColumnCount=2&rdShowElementHistory=divTopicUpdating%3dHide%2cisTopic%3dShow%2cdivYearUpdating%3dHide%2cisYear%3dShow%2c&rdScrollX=0&rdScrollY=400&rdRnd=7716

Community Resources

Demand for social services and community provided resources will likely increase due to the financial, physical, and emotional stressors created by climate change. Extreme weather will also limit access or strain existing community resources. Southern Maine has seen an influx of migration over the past few years, and this could increase as we see more climate refugees at the national and international scale. There is little data available to predict the scale of climate migration to Maine as a receiving state in the future, however, being prepared for growth is a key resilience strategy for communities. Ensuring access and capacity to increase community resources will be essential to maintaining a healthy and resilient community.

Climate refugee: People who are displaced due to climate hazards

Freeport Community Services is a vital community resource that provides a range of services to bolster community resilience. Programs include a food pantry, thrift shop, fuel assistance, summer camp scholarships, summer lunch, holiday meals and holiday helpline. As a Community Center it provides enriching activities to keep the community connected. In the 2022-2023 fiscal year, Freeport Community Services provided the following ¹:

- Nearly 180 households, or 335 people, per month access to the food pantry*
- An average of 60 meals and 25 deliveries provided twice per month through the free lunch program*
- Supported 68 children to receive food weekly through the Backpack Program during the school year*
- Provided 235 individuals with general assistance totaling over \$228,000 of food, shelter, housing, and other assistance*
- Supported 85 households, or 198 individuals, with fuel assistance through the Kaplan Fuel Fund*
- And many other resources and programs*

The continuation of this resource will ensure greater equity in the community and ensure that more individuals are able to respond to climate change.

Social Services

Losing access to key social services such as childcare or schools, libraries, and town services - whether permanently or temporarily - increases the overall vulnerability of the community. Climate disasters can also strain the capacity of these community resources, such as food pantries or financial assistance organizations, as more people experience impacts from climate change. Ensuring these services can handle the capacity while taking proactive steps to prevent dire impacts from climate hazards is crucial to maintaining a resilient community.

In Freeport

Overall, the biggest impact to services in Freeport will be restricted access during storm events, due to flooded roads and bridges. Like many other communities, residents often commute outside of Freeport for health and social services. As mentioned earlier, flooding along key roadways will limit residents' ability to access resources within Freeport and outside of the Town boundary. People may need to find alternative routes to access these services.

While the properties of several community services may experience flooding during storm events, no buildings will be directly impacted.

Table 8: Community services impacted by different flooding scenarios

Service	Resource	Impact
Schools	<ul style="list-style-type: none"> • Morse Street Elementary • Freeport Middle School • Freeport High School • Maine Coast Waldorf School • Pine Tree Academy 	All will experience some degree of flooding on the property, but it will not impact the school buildings or functions for the school.
Municipal Services	<ul style="list-style-type: none"> • Public Works • Recycling Center 	The properties may experience minor flooding but buildings and function of the property are not expected to be impacted.
Community Resources	<ul style="list-style-type: none"> • Freeport Housing Trust • Freeport Medical Center 	The properties may experience minor flooding but buildings and service will not be impacted.

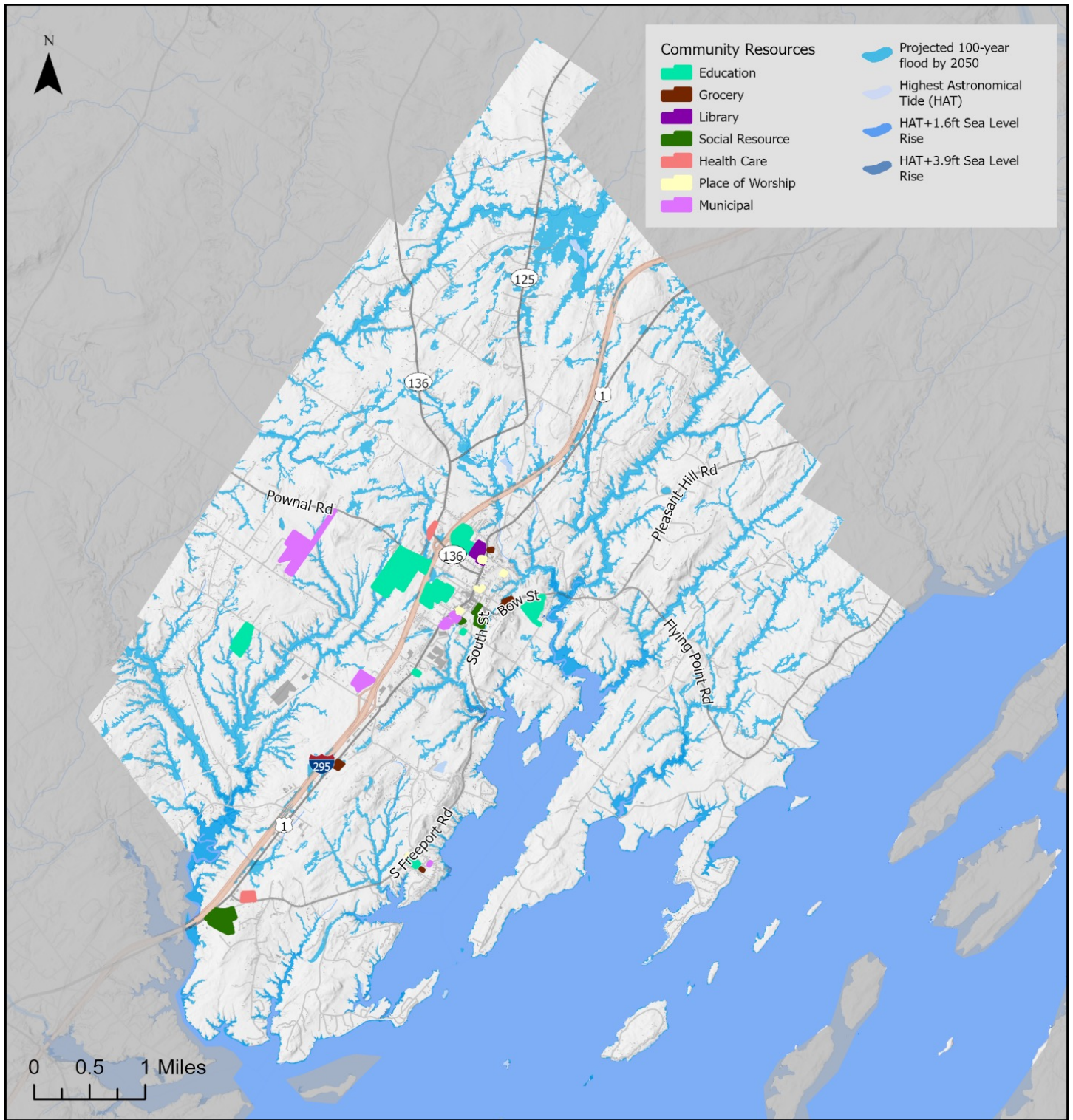


Figure 16: Key community services that are vulnerable to sea level rise or 100-year flooding by 2050. Source: Town of Freeport, Maine Geological Survey, FloodFactor

Food security

Climate change threatens to amplify food insecurity for households. Impacts will occur across the food supply system from growing and manufacturing to distribution. This includes increased food-borne illness from pathogens and contaminated water, disrupted food availability, decreasing access, disruption in shipments, or increasing prices due to fuel or product scarcity⁶⁰. Reliance on non-domestic food increases households' vulnerability to these climate-induced impacts.

In Freeport

On average, 90% of food consumed by Mainers comes from outside the state⁶¹. Similarly, Freeport residents rely heavily on external food sources and will feel impacts from price increases, shipping disruptions, or food shortages due to climate impacts. There are no food deserts in Freeport⁶².

Food deserts are geographic areas where residents with lower-incomes or no vehicles do not have access to affordable, healthy food⁶³.

Freeport has one major supermarket – a Shaw's along Route 1 – along with Bow Street Market, Royal River Natural Foods, South Freeport Village Market, CVS, and several convenience stores. The Royal River Natural Foods may be impacted by flooding during storm events by 2050. In addition, access may be limited due to flooded roads.

Food security can be worsened for those individuals who are already cost burdened. Freeport currently has the following food support services in town:

- Freeport Community Services provides a range of food programs for all ages. These programs include:
 - Vaughndella Curtis Food Pantry
 - Summer Snacks Program
 - Backpack Program
 - Community Lunch Program
 - Home Delivery
 - Holiday Meals
 - Community Garden
- Wolfe's Neck Center operates a community garden on their property
- Freeport General Assistance – assists residents with paying for basic necessities such as food and personal supplies and can assist with applying for food stamps. Freeport General Assistance operates from Town Hall.
- RSU 5 School district provides free meals for all regardless of household income

60 <https://www.usda.gov/sites/default/files/documents/FullAssessment.pdf>

61 <https://csg-erc.org/maine-right-to-food/>

62 <https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas/>

63 <https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas/>

Trails, Parks, and Preserves

Parks and trails bring many benefits for residents. Green space helps lower surrounding air temperature, promote active living, improve public health, serve as community gathering spots, increase surrounding property values, and provide ecological benefits (see Natural Resources at Risk Section)⁶⁴. Climate hazards disrupt access to the trails, parks, and preserves, but it will also require more maintenance and repair, putting strain on municipal resources. Maintaining and expanding access to these spaces creates a more vibrant community and builds resilience to climate change.

In Freeport

Freeport hosts a diverse range of outdoor activities and access to natural resources is vital to the community's character. This includes hiking trails, playgrounds, athletic fields, and parks. Almost all inventoried recreational spaces will experience impacts from sea level rise or inland flooding in 2050. Sea level rise threatens Winslow Memorial Park and Wolfe's Neck Woods State Park. While trails along the Harraseeket River and Cousin's River have the largest impacts from flooding events. The increase in flooding restricts access but also necessitates more maintenance.

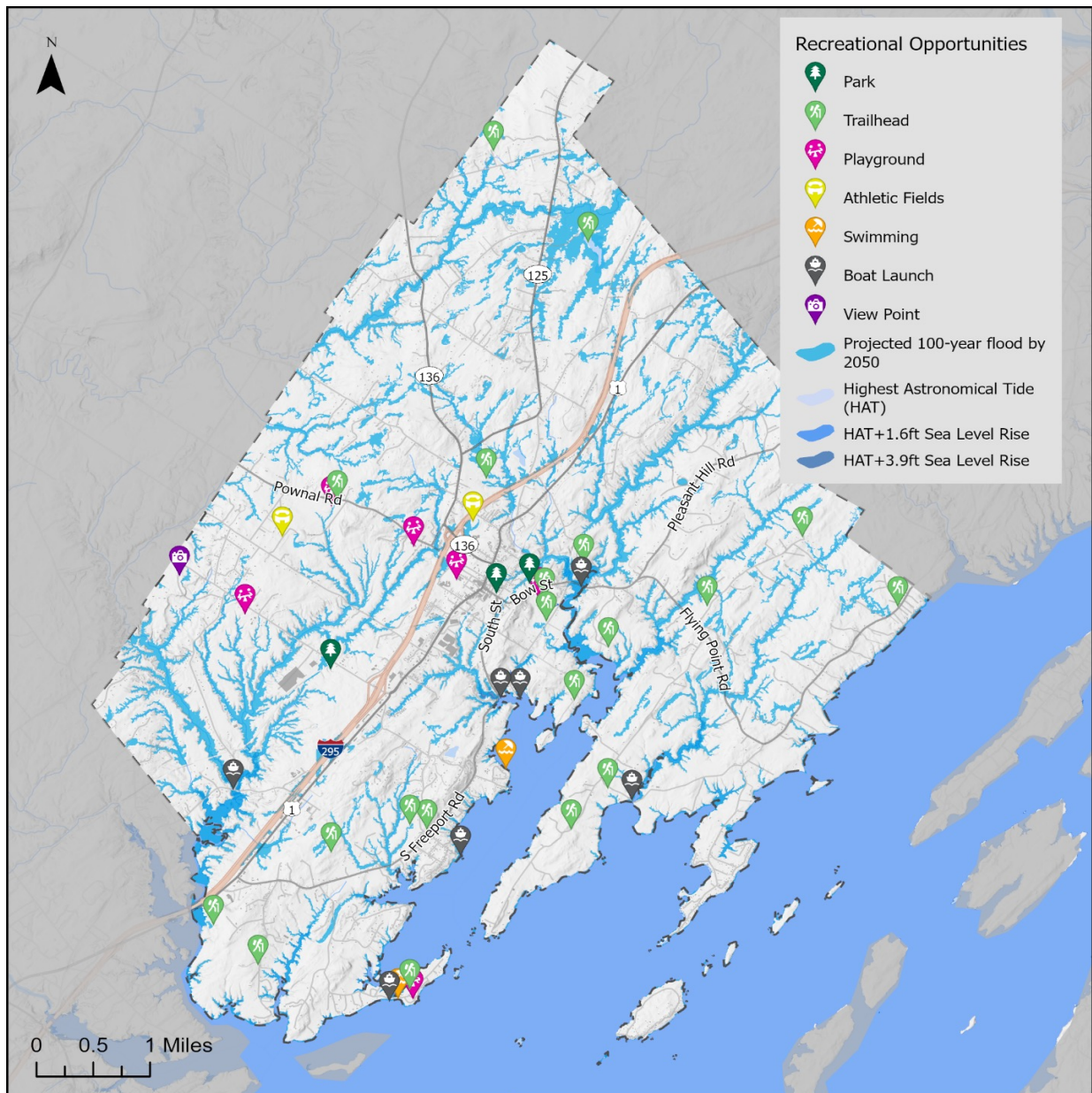


Figure 17: Parks and trails that are vulnerable to sea level rise or 100-year flooding by 2050. Source: Town of Freeport, Maine Geological Survey, FloodFactor

64 https://www.tpl.org/wp-content/uploads/2022/09/The_Power_of_Parks_to_Address_Climate_Change_-_A_Trust_for_Public_Land_Special_Report.pdf

Housing

Rising sea levels and storm intensity threaten to directly damage houses, leading to reduced property values and impacts to Freeport's tax base and real estate market. Any substantial loss or damage to the housing stock caused by storms or flooding will compound the region's ongoing housing stresses. Freeport and the whole region have existing housing security, affordability, and quality issues. This section highlights particularly vulnerable housing communities within Freeport.

Access: A lack of available or affordable housing in Freeport and the surrounding region means a growing percentage of the labor force will have to commute further for work. As housing prices also rise regionally, workers may commute from outside the Greater Portland area over time, leading to both higher greenhouse gas emissions and greater vulnerability for climate-related transportation interruptions. Similarly, since many Freeport residents work outside of Town boundaries, residents run the risk of losing access to their jobs which impacts the regional economy or being unable to get home in case severe weather hits during working hours.

Affordability: Freeport's cost-burdened homeowners and renters already face financial insecurities. As climate hazards damage properties, force temporary or permanent evacuation, or require increased maintenance it will continue to increase housing costs. Investing in flood insurance, retrofitting buildings, or investing in flood-resistant properties are often unattainable for cost-burdened households. A lack of affordable housing will continue to push people out of town and place financial burdens on those who stay, making responding to climate change difficult. Elderly residents who live on fixed income, those in affordable housing complexes, and people living in manufactured homes are vulnerable to housing impacts from climate change.

In Freeport

Freeport has several senior living and affordable housing communities, including a mobile home community. There will be very few direct impacts to these housing properties. Beyond the direct impacts of flooding, the Town needs to consider access issues and communication about climate impacts to these communities. As well as the ability for these communities to retain access to affordable resources.

The following two properties may experience a minor degree of flooding during storm events by 2050 but no buildings will be impacted:

- Brookside Village Senior Apartments
- Varney Square Apartments

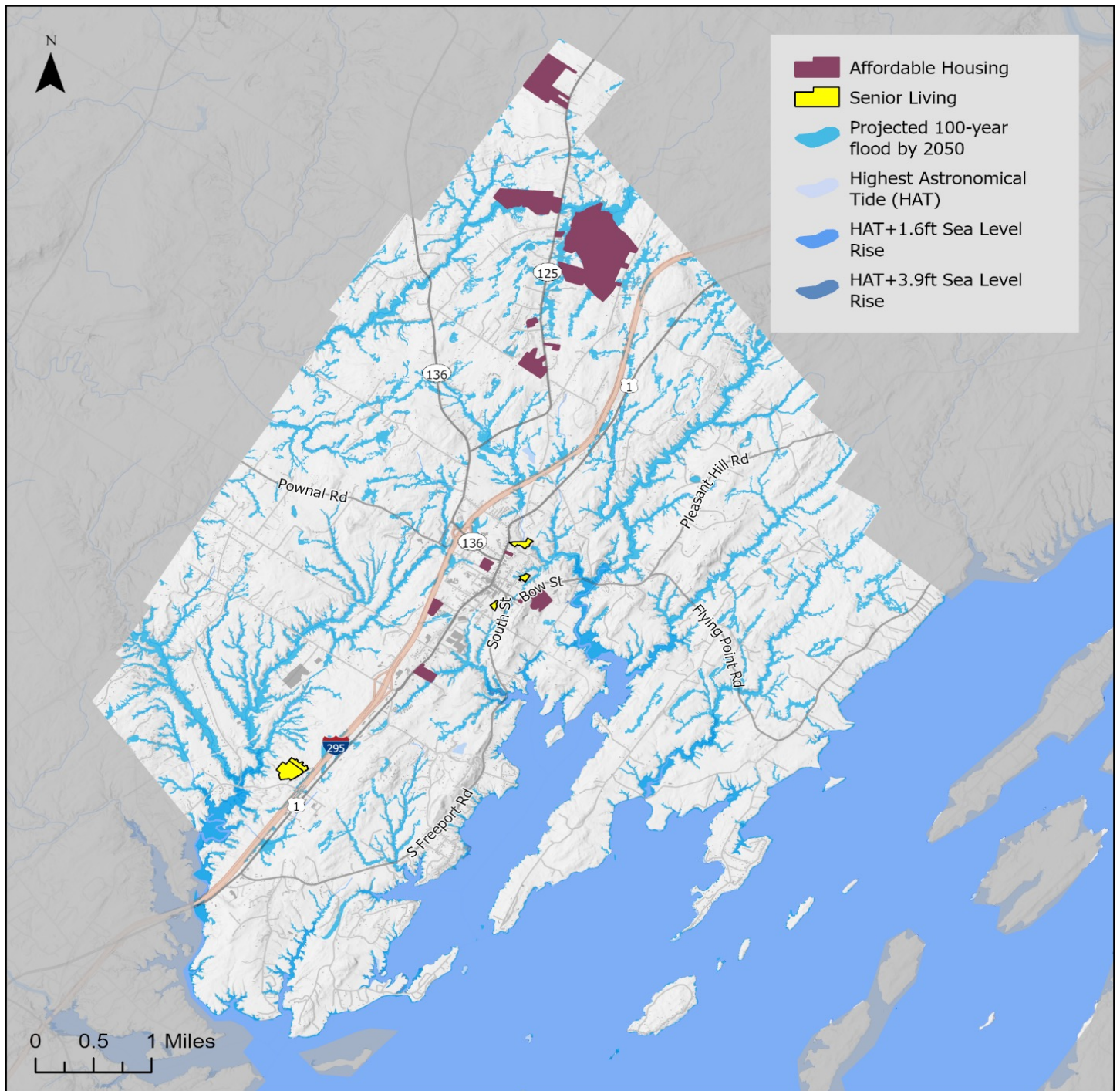


Figure 18: Vulnerable housing communities that are at risk of flooding due to sea level rise or 100-year flooding by 2050. Source: Town of Freeport, Maine Geological Survey, FloodFactor

Historic sites

Climate change threatens the integrity of historic structures and sites. Sea level rise and eroding coastlines can result in permanent loss of historically significant places, while increasing storms and flooding may damage structures. The Maine Historic Preservation Plan cites the challenge of protecting historic and archaeological resources from the effects of climate change ⁶⁵. Rehabilitating historic buildings to be more sustainable can be challenging due to modern building codes, cost and effort to improve energy efficiency, and securing funding. Archaeological sites are also of great concern, especially those along the coasts which may be lost to sea level rise or eroding bluffs.

The State is committed to collaborating with partners to assess the impact of climate change and providing greater protections for particularly vulnerable resources ⁶⁶.

In Freeport

The town has five properties listed on the National Register of Historic Places, including two historic districts. Listing in the National Register indicates that the property is recognized as historically significant at a regional, state and/or national level. None of the listed structures will be impacted by flooding or sea level rise. Some buildings within the historic districts are vulnerable to flooding, however, further analysis would be needed to know if this would impact the District's listing status.

Most archaeological site locations are kept confidential to protect the resources, therefore, the vulnerability of archaeological sites has not been identified through this report. The Town should review past surveys and consider conducting additional surveys in areas that are vulnerable to flooding or sea level rise that may contain these resources.

⁶⁵ https://www.maine.gov/mhpc/sites/maine.gov/mhpc/files/inline-files/Approved%20State%20Plan%2010_2021.pdf

⁶⁶ https://www.maine.gov/mhpc/sites/maine.gov/mhpc/files/inline-files/Approved%20State%20Plan%2010_2021.pdf

Economy and Livelihoods

Climate change impacts businesses' physical properties, changes the demand and type of employment, affects commuting patterns, and ultimately impacts the overall economy of a community. In a region reliant mainly on private vehicle transportation, both workers and businesses are vulnerable to temporary flooding and long-lasting damage to roads. Changing temperatures and ocean conditions makes the natural resource industry particularly vulnerable to shocks and stressors.

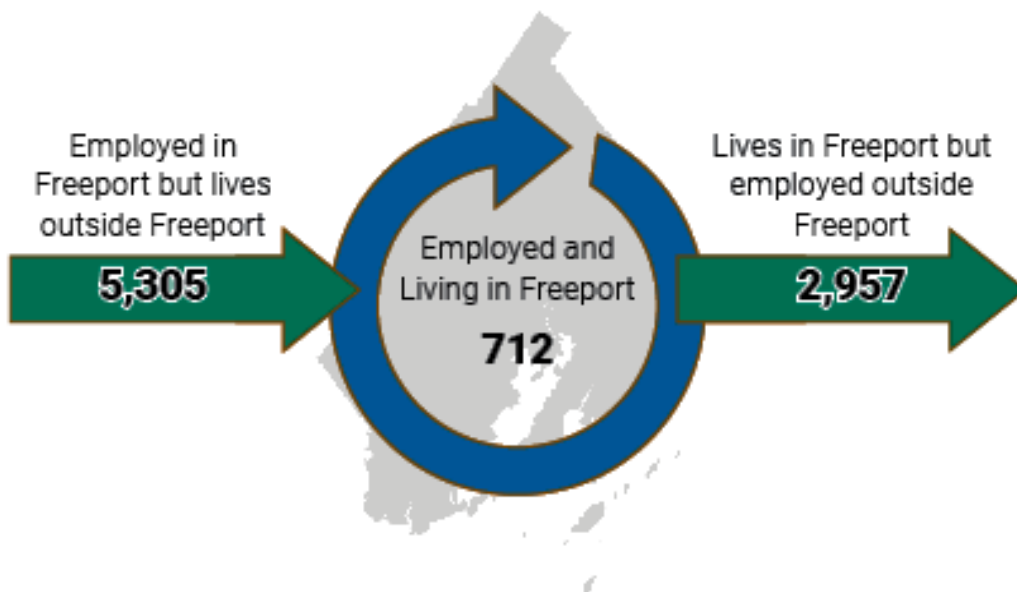
Businesses and Industries

Sea level rise threatens waterfront restaurants and businesses and access to critical working waterfront points of entry, including the loss of docks limits recreational sailing and marine tourism. Food service and hospitality businesses will experience changes as the number and visiting days for tourists shift due to the changing seasons. With Maine winters becoming shorter, recreational activities like ice skating and skiing will be limited by less snowfall. Not only will climate change impact the physical properties but it can shift industry demand.

In Freeport

In 2022, the major industries of employment in Freeport were Retail Trade, and Accommodation and Food Service. These two industries made up 30% of employment in town ⁶⁷. The Maine Department of Labor shows 551 establishments which employ almost 6,500 people. Changes in the seasons can impact the retail and food industries and overall employment. In 2022, over 800 more people were employed during quarter 4 than quarter 1 ⁶⁸.

The biggest threat to businesses will be access and damage during flooding events. A vast majority of Freeport's labor force (including Town staff) live in neighboring communities, while most employed Freeport residents commute out of town to work, primarily by car. Continued reliance on attracting workers who live outside of town not only increases greenhouse gas emissions, but also increases the vulnerability of businesses to bounce back during a climate event.



⁶⁷ <https://www.maine.gov/labor/cwri/qcew1.html>

⁶⁸ <https://www.maine.gov/labor/cwri/qcew1.html>

Essential services

Access to supermarkets, health care, emergency services, schools and municipal buildings may be cut off due to flooding of roads and bridges. This prevents people from getting to their jobs or receiving those services. In addition to physical access, the increase in impacts to public health will strain the healthcare system and limit healthcare availability. Similarly, rising costs and financial constraints will overwhelm critical resources. The indirect strain placed on essential services will impact the overall system as much or more than the physical impacts of climate change.

In Freeport

Most municipal staff, including first responders, commute to work in Freeport. During a severe weather event first responders will face difficulty coming to the Town to provide support, and once in town could face difficulty getting resources to residents and businesses. While there are several health services within the town, Freeport residents would rely on hospitals in Portland or Brunswick for emergency care. Roads projected to flood in 2050 could limit access to these communities. To date the town emergency services (police, fire, EMS) have not experienced any difficulty in access.

Natural resource economy

Maine's economy is heavily reliant on natural resources from fishing to forestry. As temperatures rise these sectors are increasingly under threat. Individuals who rely on these fisheries for their livelihoods, especially lobster, may experience economic impacts as species' ranges shift with climate change. Recreational fishing opportunities for non-commercial license holders may also be impacted, representing a significant cultural loss for the community. In addition, the loss of docks from sea level rise threatens access to the waterfront.

In Freeport

Only 1% of Freeport's population is employed in agriculture, forestry, fishing or hunting. However, the largest natural resource economy within Freeport is the marine industry.

In 2022, the Maine Department of Marine Resources issued 168 licenses to Freeport⁶⁹. This includes 4 aquaculture licenses, 94 commercial fishing licenses, and 70 non-commercial licenses. Most commercial licenses are for Shellfish. In addition, there were 9 NOAA Vessel Permits⁷⁰.

The total landings in Freeport equated to over 865,000 pounds valued at almost \$2.4 million⁷¹. Since 2008, softshell clam and lobster have been the primary landings species –both for weight and value. Changes in ocean conditions are already impacting the type of species harvested. Continued changes will impact both individual livelihoods but also the town's earnings. Water quality in Casco Bay is already a challenge and impacts the shellfish industry, flats are often restricted in Freeport due to maintenance at the wastewater treatment facility or other water quality issues. More information on closures due to water quality challenges can be found in the Natural Resources at Risk section.

69 <https://www.maineoastfishermen.org/working-waterfront-inventory>

70 <https://www.greateratlantic.fisheries.noaa.gov/public/public/web/NEROINET/aps/permits/data/index.html>

71 https://mainedmr.shinyapps.io/Landings_Portal/

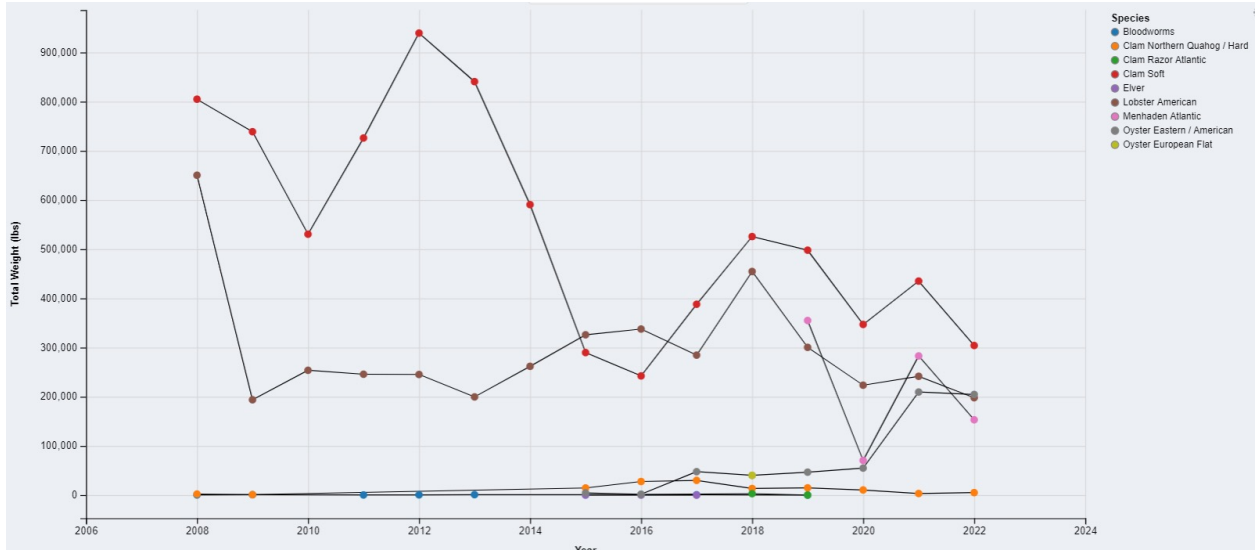


Figure 19: Total weight (lbs.) per species for Freeport port from 2008 to 2022. Source: Maine DM

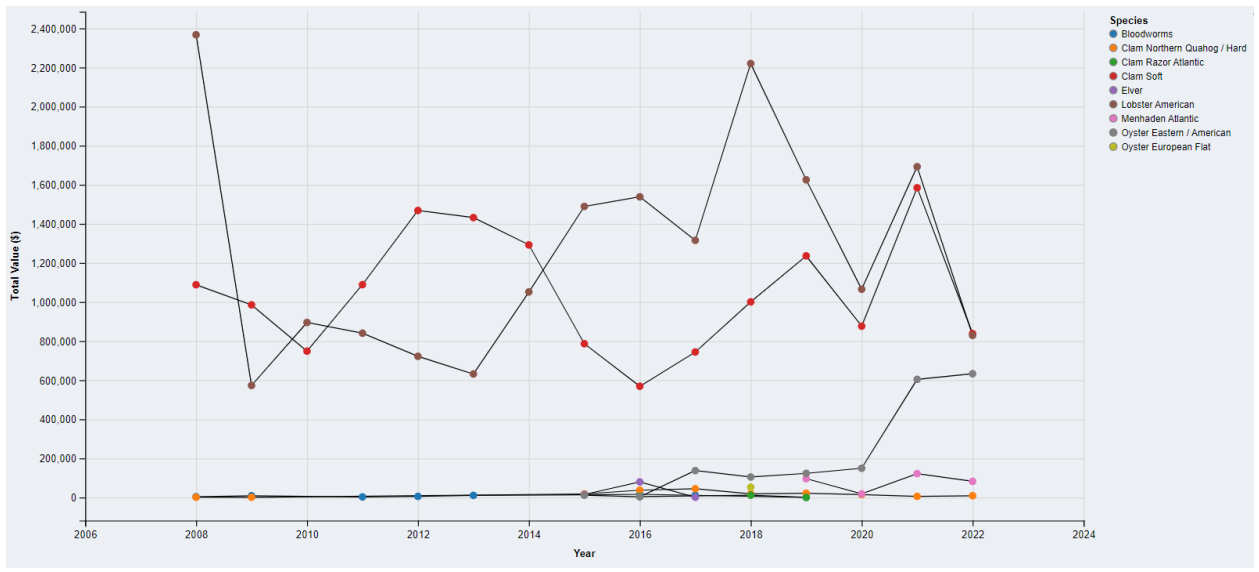


Figure 20: Total Value (\$) per species for Freeport port from 2008 to 2022. Source: Maine DMR

Property values/tax base

In addition to the economic costs of property damage, climate change is impacting property values. Property values are higher for land on higher elevations due to their lower risk of flooding. As properties become increasingly exposed to flooding, their market and assessed values could decline, reducing local tax revenues from affected parcels and potentially straining municipal fiscal health. Similarly, as climate change degrades water quality, property values are lower on lakes with poor water clarity and increased algal blooms ⁷².

Tidal flooding caused by sea level rise has been estimated to have eroded more than \$70 million in Maine coastal real estate value, with most of that occurring in southern Maine ⁷³. Substantial loss or damage to housing will reduce a town's tax base, impacting municipal budgets. The municipal tax base will also be affected by increased damage and frequency of repairs needed to infrastructure. It is also possible that federal and state taxes will increase due to emergency management services and government flood insurance programs requiring higher capacity.

In Freeport

Property impacts in Freeport will affect overall property values and the municipal tax base. Almost 2,000 parcels and over 100 buildings would experience flooding during a severe event by 2050. This can equate to millions of dollars in damage and property loss. Assessor information was not available for this analysis, but Freeport should consider conducting a future economic analysis of climate change in the future to fully assess impacts.

Flood insurance

As the risk of flooding increases, the chances of flood-related expenses go up. As the risk of damage and expenses increases so will the cost of flood insurance. In April 2023, FEMA fully implemented Risk Rating 2.0, National Flood Insurance Program's (NFIP) pricing methodology. This methodology addresses rating disparities by incorporating more flood risk variables to equitably distribute premiums across policyholders based on home value and a property's flood risk ⁷⁴. However, in 2021, First Street Foundation calculated the average expected annual damage per Maine property within a special flood hazard area to be \$4,381 while the average insurance premium was only \$1,285 ⁷⁵. This suggests that even with insurance, it does not meet the full cost of flooding impacts. First Street Foundation also found that the risk and cost of those living outside of FEMA designated flood areas have been historically underestimated. Properties outside of FEMA's designated special flood hazard areas account for only 2% of flood insurance policies but account for 20% of all claims and receive 33% of federal disaster assistance for flooding ⁷⁶. Even with the updated Risk Rating 2.0, it is likely that flood insurance will only cover a portion of the properties and impacts.

72 <https://www.maine.gov/dep/water/lakes/research.html>

73 <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

74 <https://www.fema.gov/flood-insurance/risk-rating>

75 https://assets.firststreet.org/uploads/2021/02/The_Cost_of_Climate_FSF20210219-1.pdf

76 https://assets.firststreet.org/uploads/2021/02/The_Cost_of_Climate_FSF20210219-1.pdf

Natural Resources at Risk

Climate hazards strain the health of marine and terrestrial ecosystems. Climate change has already begun to strain ecosystems and has the potential to lead to long-term impacts. Changes in temperature and precipitation are expected to increase stress and disturbances in forests. As ecosystems are transformed, species will migrate to more desirable habitats. The Gulf of Maine and Casco Bay exchange nutrients and support marine species important to southern Maine’s coastal economy and identity. Understanding how and where the environment is vulnerable can guide decision-making to conserve and protect Freeport’s natural resources.

Key Takeaways

Overview	Freeport has a large variety of natural resources. There is a lot of room to conserve lands but impaired waters also strain these valuable assets.
Shifting Ecosystems	Freeport is seeing an increase in pests and invasive species due to warming temperatures and changing precipitation patterns. These changes put pressure on native ecosystems and disrupt the health of natural resources.
Marsh Migration	Freeport currently supports marsh migration from sea level rise due to the forested land cover along the coast. However, these areas are not permanently conserved and risk development.
Coastal and Inland Erosion	While there are areas of the coast which are unstable, most areas do not contain critical infrastructure. Although Freeport is relatively protected from sea level rise due to its elevated shoreline, erosion of coastal bluffs is impacting coastal properties and natural systems. Armoring shorelines with hard infrastructure can compound these issues and impact adjacent properties. Nature-based solutions like living shorelines should be explored where appropriate
Conserved Lands	The town only has approximately 14% of land conserved ⁷⁷ . Increasing the amount of dedicated conserved land will support water and air quality, future marsh migration, and contribute to carbon sequestration.
Water Resources	Water quality is one of the largest concerns for Freeport. Inland waters are already impaired so improving water quality will be key to supporting the health of aquatic resources.
Agriculture	While some parcels will be impacted by flooding, agriculture makes up a small portion of land in town.
Forests and Carbon Sinks	Freeport is losing open space and critical forests, but the town has the opportunity to protect more lands to serve as carbon sinks and mitigate the impacts of climate change.
Geographic areas of concern	Coastal areas support tidal marsh migration and critical species habitat that are vital to a healthy ecosystem.

⁷⁷ https://www.maine.gov/dacf/parks/publications_maps/conservation_lands_maine.html

Shifting Ecosystems

Warmer air and water temperatures cause shifts in species' geographic ranges, leading to declines in native marine and terrestrial life, and increases in invasive species, pathogens, and pests. These shifts make ecosystems more vulnerable to stressors such as invasive species and habitat destruction. Rising sea levels and increased flooding may eliminate habitats for sea bird species. These changes put even greater pressure on already threatened or endangered species.

Maine's fishing industry is particularly susceptible to species migration due to warming water temperatures and ocean acidification. Recent research predicts that lobster populations are likely to shift 200 miles further north because of climate change ⁷⁸. However, other research suggests that Gulf of Maine waters may remain resilient and suitable for lobster populations ⁷⁹. Atlantic Cod populations in the Gulf of Maine have been declining since before 1990, and recent research suggests that the remaining habitat for the species in the North Atlantic could shrink by over 90% by 2100 due to warming waters ⁸⁰.

In addition to forcing native species to shift further north, new climate-induced conditions in marine and terrestrial ecosystems are causing invasive, non-native species to migrate into Maine. Invasive plant and marine species disrupt ecosystems by developing self-sustaining populations that are dominant or disruptive to native species by outcompeting them for resources.

Invasive species are plants and wildlife that spread to the point that they can cause harm to ecosystems, usually out-competing local species for resources or hunting prey down to dangerously low populations.

Impacts in Freeport

In Cumberland County, with a 2C (3.6F) increase in temperature, 3 bird species are highly vulnerable, and 57 bird species are moderately vulnerable to changing habitat conditions ⁸¹. Freeport has areas that are home to vulnerable wildlife such as the Saltmarsh Sparrow and Blue Heron. The largest habitat area is along the Cousins River boarding the Town of Yarmouth.

Freeport's coastal waters play home to a range of shellfish and marine species that are at risk from rising temperatures and acidification. One important marine resource that has seen a decline due to warming temperatures is eelgrass. Eelgrass is a native seagrass that provides critical habitat and food for other marine species, supports healthy water quality by managing nutrients in the water and stabilizing sediment, and can sequester carbon. Based on the last survey, the waters around Freeport have lost all existing eelgrass.

Invasive Species: Freeport is already seeing invasive species throughout town. The 2019 Street Tree Inventory found that many neighborhoods have wooded areas that are not maintained but appear to harbor invasive and noxious plant species ⁸². Areas along Kendall Street and Park Street in particular were called out. The report also mentioned the increasing threat of emerald ash borer and Asian longhorn beetle, although they had not yet been observed in town. Monitoring across town is limited and the report recommends increased monitoring and management of invasive species.

Freeport is also not immune to invasive marine species. Research by Casco Bay Estuary Partnership found that at two sample locations in Casco Bay, between one-fifth and one-third of all identified marine species were not native ⁸³. One example is the European green crab, which damages local shellfish population and habitat. The green crab disturbs the sediment and uproots beds while foraging ⁸⁴.

78 Morley, J. et. al., (2018). Projecting shifts in thermal habitat for 686 species on the North American continental shelf. PLoS One.

79 Portland Press Herald. (2022). Scientists see long-term hope for Maine's lobster fishery despite warming waters.

80 Morley, J. et. al., (2018). Projecting shifts in thermal habitat for 686 species on the North American continental shelf. PLoS One.

81 Audubon. <https://www.audubon.org/climate/survivalbydegrees>

82 https://www.freeportmaine.com/sites/g/files/vyhli4436/f/uploads/freeport_street_tree_inventory_report.pdf

83 Casco Bay Estuary Partnership. (2021). State of Casco Bay

84 Casco Bay Estuary Partnership (2015). Eelgrass beds decline as green crab numbers explode.

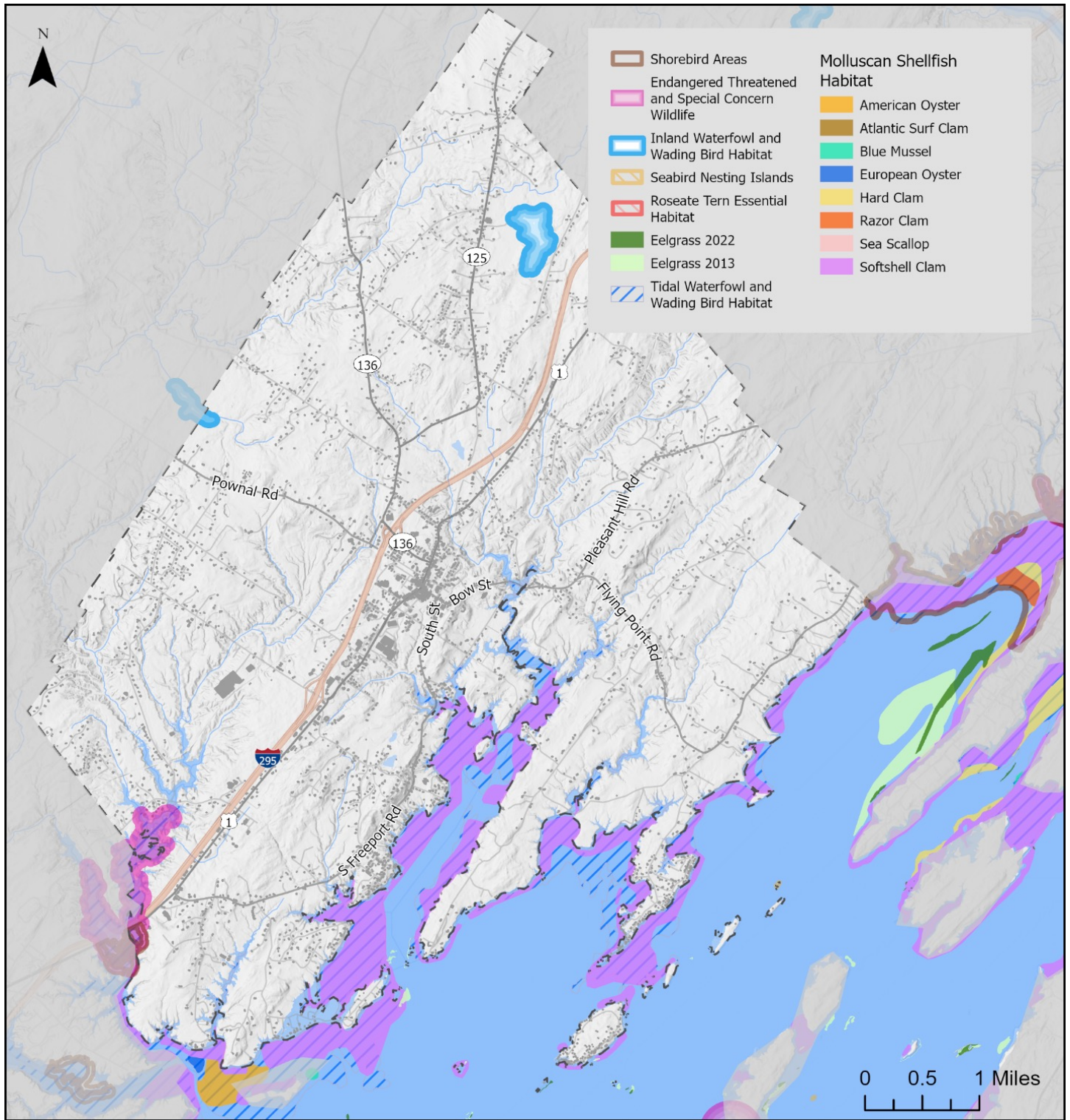


Figure 21: Aquatic and sensitive species habitat in Freeport. Source: Town of Freeport, Maine DEP, Maine Inland Fisheries and Wildlife, Maine Geological Survey, FloodFactor

Marsh Migration

Tidal areas such as marshes and wetlands are particularly sensitive to climate change. These ecosystems provide tremendous benefit to wildlife, plant species, and the surrounding built environment by serving as habitat and a protective barrier against storm surge and rising sea levels. Marshes also have the natural ability to filter pollution and slow the impacts of erosion, as well as sequester carbon from the atmosphere. Preserving and protecting marsh and wetland areas improve the resiliency of surrounding coastal communities.

As sea levels rise, tidal marshes gradually shift inland onto formerly dry land or nontidal areas. This process, known as marsh migration, is possible only as long as there are no constraints from the built environment or steep slopes in the area. In areas where marshes border development such as roads or buildings, migration may not be possible, resulting in the loss of marshes and an increased risk to the developed area of future storms.

Impacts in Freeport

Maine Geological Survey has mapped potential marsh migration for 1 ft, 2ft, and 3.3 feet of sea level rise. Table # shows the potential additional marsh migration acreage in Freeport for each of these scenarios. There are five main areas in Freeport identified as able to support marsh migration: (1) Cousin's River, (2) Lambert Point Stream, (3) Winslow Park, (4) Harraseeket River, and (5) Little River. Overall, most of Freeport's tidal marshes are already surrounded by conserved land and will provide good protection against flooding if these areas remain conserved.

Table 9: Acres of current tidal marshes and how many square miles are needed under different sea level rise scenarios to accommodate marsh migration. Source: Maine DEP

Scenario	Existing	1 ft Sea Level Rise	2 ft Sea Level Rise	3.3 ft Sea Level Rise
Potential Marsh Migration (acres)	19.1	19.5	36.4	56.8

- Cousin's River: One of the larger tidal marsh areas in Freeport is along the Cousin's River. Most of the land surrounding this area is forested, and much of the land to the southeast is already conserved. As sea level rises, tidal marshes could extend past Old Country Road. Future development in this area could impede migration.
- Lambert Point Stream: The area to the east of Lambert Point Stream is already conserved which will provide ample room for marsh migration. There are several houses to the west which may start to see encroachment as sea levels rise.
- Winslow Park: There are existing marsh areas long the coast by Winslow Park. Winslow Park is already conserved, and most of the land to the north is undeveloped which would support marsh migration. However, neighborhoods along Staples Point Road may start to see encroachment from the tidal marshes.
- Harraseeket River: There are several large areas of existing marshes along the Harraseeket River – at the mouth of Concord Gully, Frost Gully Brook, and Kelsey Brook. This area is already largely conserved and provides ample room for marsh migration. However, development around Porter's Landing may hinder migration. Further, as sea level rises, tidal marshes will continue to migrate past Bow Street and could threaten development in this area.
- Little River: The land surrounding this area is largely undeveloped or conserved. As sea level rises, tidal marshes will continue to migrate up the river. Future development in this area could impede migration.

The Community Intertidal Data Portal ⁹⁹, developed by Tidal Bay Consulting and the Greater Portland Council of Governments, is an interactive online mapping tool that allows users to more easily zoom in and out of these areas to get a better understanding of tidal marshes may be impacted near them.

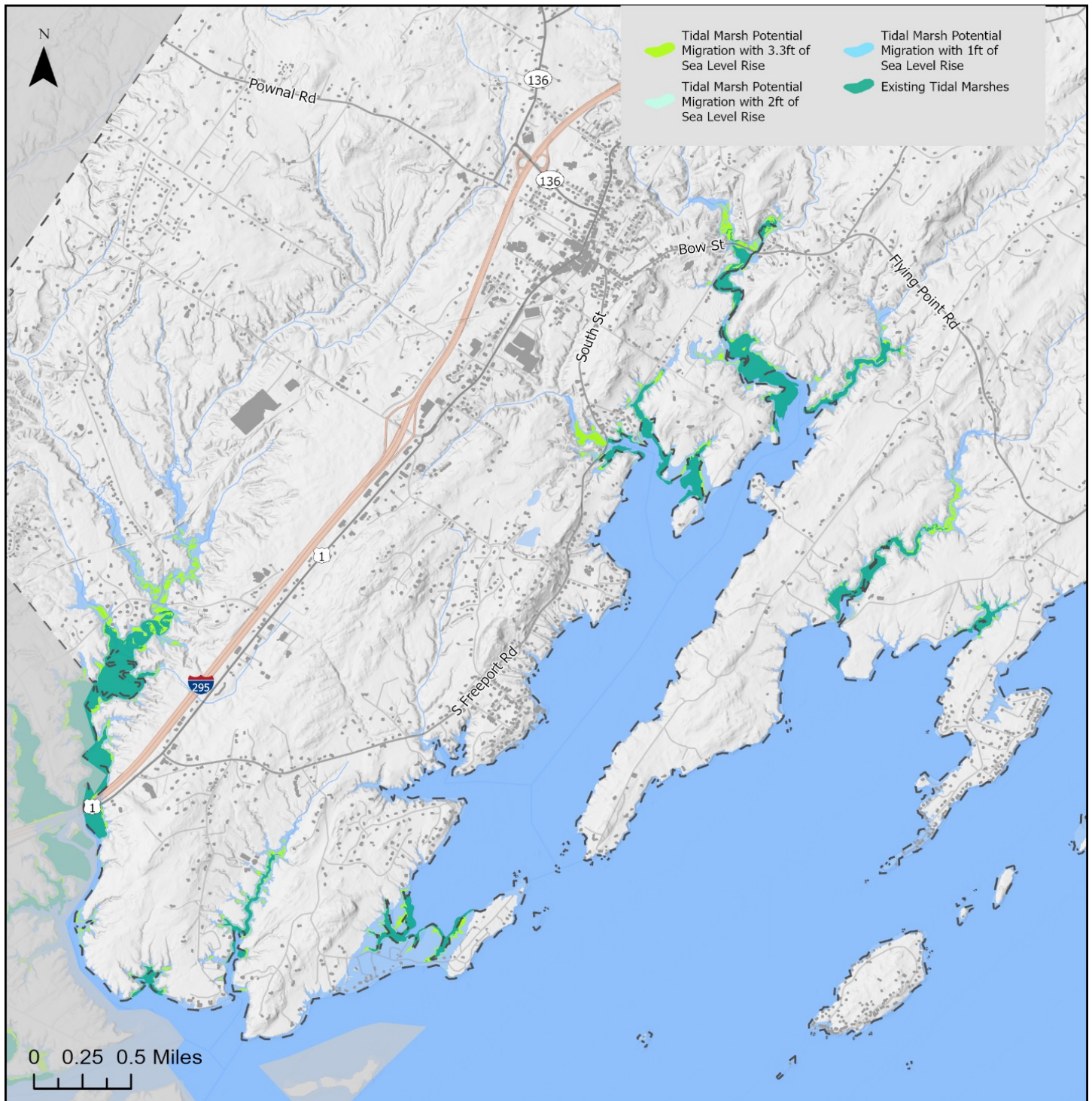


Figure 22: Existing tidal marshes and potential tidal marsh migration under 1 ft, 2ft, and 3ft of sea level rise. Source: Town of Freeport, Maine DEP

Coastal and Inland Erosion

Coastal erosion is a process by which severe storms, flooding, sea level rise, and human-related activities wear away beaches, dunes or coastal bluffs. Erosion of the shoreline increases risk of coastal flooding, decreases habitat, and removes natural storm and flood barriers, making adjacent infrastructure more vulnerable. In addition to coastal erosion, increased precipitation threatens the integrity of inland waterways and makes them prone to landslides. Inland flooding can change the composition of soil along riverbanks and compromise the integrity of pre-existing structures built along inland waterways. In the 2022 Cumberland County Hazard Mitigation Plan ⁸⁵, erosion and coastal flooding were among the most prevalent hazards in the county. The slope of the land, sediment type, vegetation, bedrock, and surrounding upland land use can all impact the vulnerability of coastal and inland erosion.

Impacts in Freeport

According to data from the Maine Geological Survey, a large portion of the coastline are on unstable or highly unstable bluffs, while other areas are at risk for a landslide. Some of this data is out of date and coastal bluffs should be monitored locally to track changes. Historically, there are records of coastal landslides along the shores of Freeport ⁸⁶. There are also beaches and sand dunes on the east side of Bartol Island Road that are subject to erosion and overtopping. Beach and dune health should be monitored and evaluated for potential stabilization and restoration efforts.

Inland Freeport has relatively stable waterways although there are three recorded instances of landslides ⁸⁷; however, all three are considered prehistoric. Climate change can increase the likelihood of landslides in susceptible areas and should be monitored. Further studies may be necessary to better understand the risks of Freeport's riverbanks.

⁸⁵ https://cms4files1.revize.com/cumberlandcounty/Departments/Emergency%20Management/Hazard%20Mitigation/Final%202022%20Plan%2012-13-21_1.pdf

⁸⁶ https://digitalmaine.com/cgi/viewcontent.cgi?article=1249&context=mgs_maps

⁸⁷ <https://www.maine.gov/dacf/mgs/hazards/landslides/inland/index.shtml>

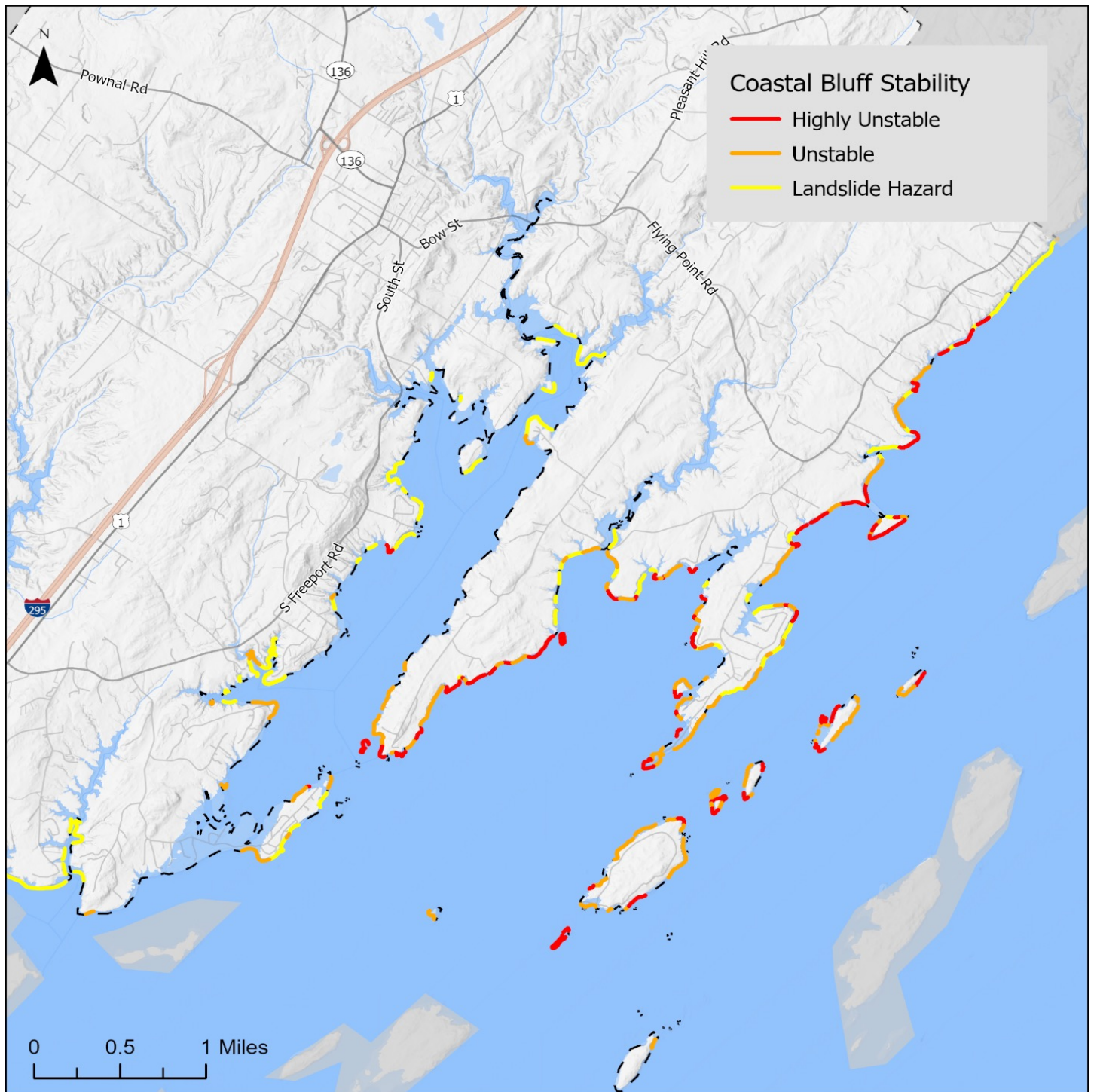


Figure 23: Coastal bluff stability. Source: Town of Freeport, Maine Geological Survey

Conserved Lands

Conserved lands, particularly forests and ecologically important areas can assist with habitat retention, as well as flood mitigation by allowing water to infiltrate below ground. Maintaining natural areas also helps maintain good water and air quality. Additionally, these areas act as carbon sinks to help remove carbon dioxide from the atmosphere and help mitigate the effects of climate change. However, warming temperatures put these natural resources at risk by shifting the ecosystem and increasing the presence of invasive species.

Impacts in Freeport

The Town has 3,025 acres of conserved land, accounting for approximately 14% of the Town's total land area. The largest area is Wolfe's Neck, however, most conserved areas will experience some degree of flooding during a 100-year flood event in 2050.

There are several undeveloped blocks of land that have the potential to be conserved which would help maintain open space and preserve areas for marsh migration. Most parcels of undeveloped land are privately owned.

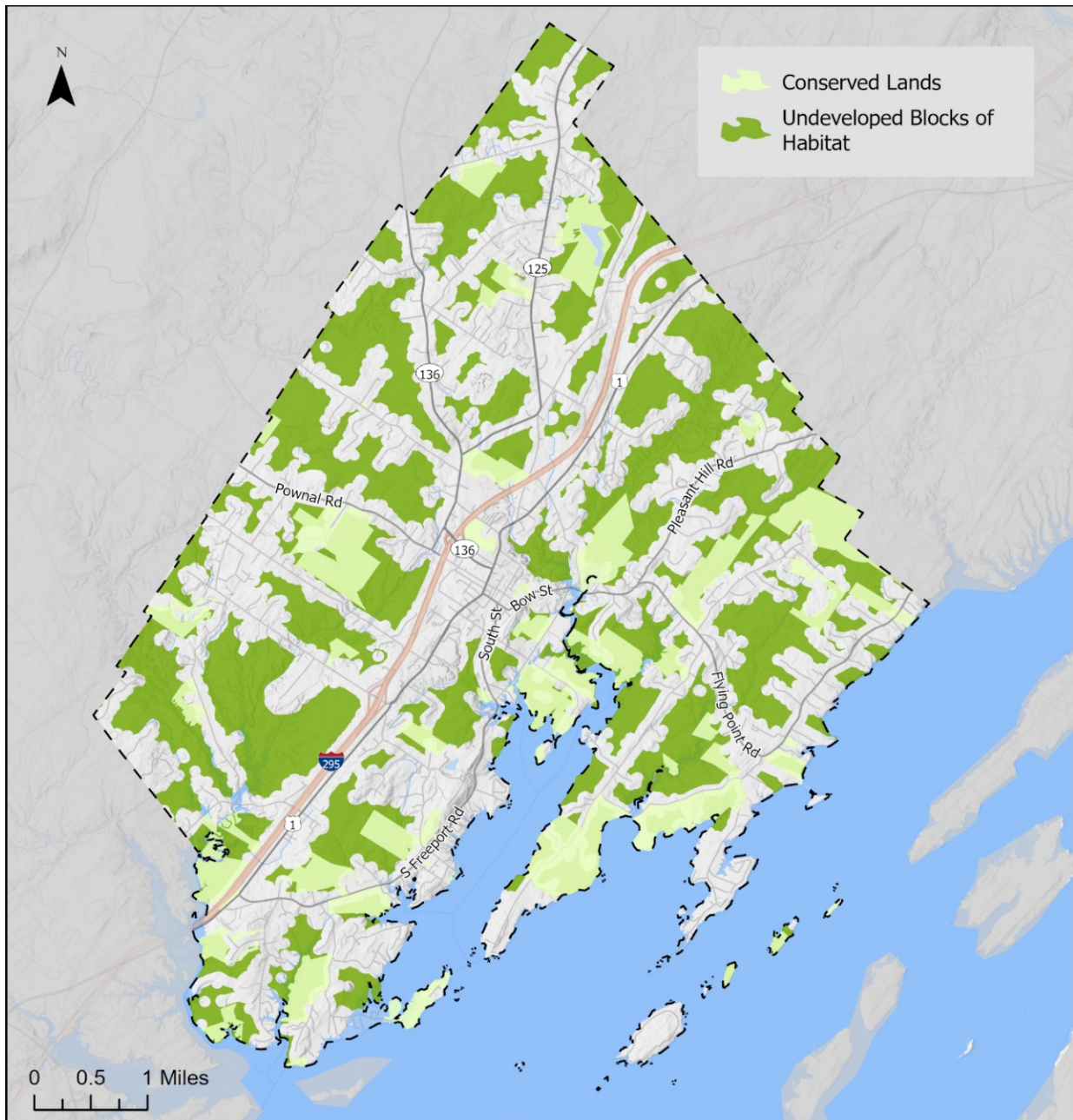


Figure 24: Conserved lands and undeveloped block of habitat. Source: Town of Freeport, Maine DEP, Maine Inland Fisheries and Wildlife

Water Resources

As mentioned earlier, increased precipitation and more intense storms create a greater volume of stormwater runoff, which delivers pollutants such as nutrients, sediment, bacteria, and trash into waterbodies. These pollutants and excess nutrients impair rivers, streams, lakes, and coastal waters. Combined with warming temperatures, climate change negatively impacts water resources by harming aquatic life, promote shifts in invasive species, and increase algal blooms ⁸⁸.

Water bodies must have sufficient dissolved oxygen to support healthy aquatic communities. Low levels of dissolved oxygen cause stress, and at very low levels aquatic organisms may suffocate ⁸⁹. Warming waters leads to lower dissolved oxygen levels and strain aquatic ecosystems. See earlier sections for how changes in water resources from climate hazards impact human health and the economy.

In Freeport

Rivers, streams, brooks, and the coastal waters running through Freeport offer important locations for wetland ecosystems, recreation, and critical species habitat. Maintaining and supporting these water resources is vital to preserving the community character.

Inland waterways

Frost Gully Brook and Concord Gully in Freeport are listed as impaired waters ⁹⁰. These flow into the Harraseeket River. Stormwater runoff from impervious cover is likely the largest source of pollution to both the Concord Gully and Frost Gully Brook ⁹¹. According to monitoring from the Friends of Casco Bay, the Harraseeket River region often has low dissolved oxygen, high chlorophyll, high nitrogen, low pH, or some combination, indicating challenged water quality ⁹².

However, Freeport and partner organizations are taking steps to improve the water quality and surrounding habitat. In 2020, the Town of Freeport replaced the West Street Culvert to mitigate intense stormwater flows that have eroded the banks of Concord Gully ⁹³. In the summer of 2023, three dams were removed along Frost Brook Gully ⁹⁴.

However, there still are a number of barriers within the Harraseeket River region that restrict habitat and impact water quality ⁹⁵. Many of these dams restrict habitat and impact water quality. Warmer waters and the construction of dams, roads, and railways cause a severe decline in fish population ⁹⁶.

88 http://climatecouncil.maine.gov/future/sites/maine.gov.future/files/inline-files/GOPIF_STS_REPORT_092320.pdf

89 <https://indd.adobe.com/view/2f8cb7b4-5b37-4c50-8c4e-5aa0c92e1fa4>

90 <https://maine.maps.arcgis.com/apps/webappviewer/index.html?id=dffb3d2b85904b18978d02fc9d913b5f>

91 https://www.maine.gov/dep/water/monitoring/tmdl/2012/Appendix_8_Concord_Gully.pdf, https://www.maine.gov/dep/water/monitoring/tmdl/2012/Appendix_10_Frost_Gully_Brook.pdf

92 <https://www.cascobay.org/our-work/science/seasonal-sampling-across-casco-bay/#:~:text=The%20Harraseeket%20and%20Fore%20River%20regions%20often%20have%20low%20dissolved,combination%2C%20indicating%20challenged%20water%20quality>

93 <https://www.pressherald.com/2020/06/23/freeport-culvert-project-aims-to-improve-water-quality-habitat-at-concord-gully/>

94 <https://static1.squarespace.com/static/628bcb223078e12b645aa87f/t/65031a3dc001315cf823c8e6/1694702164806/2023+FCT+June+Newsletter+final.pdf>

95 <https://webapps2.cgis-solutions.com/MaineStreamViewer/>

96 <https://indd.adobe.com/view/2f8cb7b4-5b37-4c50-8c4e-5aa0c92e1fa4>

Coastal Waters

Changing ocean conditions will create challenges for the region ⁹⁷. The shellfish industry in Casco Bay has seen repeated and continuous closures due to related water quality challenges. Waters around Casco Bay are often classified as prohibited by the Maine Department of Marine Resources and closed to shellfish harvesting due to either water quality testing showing elevated levels of fecal bacteria, or when an area is near a wastewater treatment plant outfall or other source of pathogens ⁹⁸. Most of Harraskeet River has closure restrictions. The waters around the wastewater treatment plant are prohibited, while the rest of the waters have restrictions in place and will close during heavy rains or when there is a malfunction with the treatment plant ⁹⁹. There is an additional closure around Bustins Island.

Closures can also reach beyond Casco Bay. In the winter of 2017, a harvesting ban stretched from Portland to Harpswell when shellfish showed elevated domoic acid levels, a biotoxin produced by a large phytoplankton bloom ¹⁰⁰. These closures impact shellfish harvesting, fisheries operations, local jobs, and the economy. In the summer of 2023, the Gulf of Maine saw a widespread bloom of brown algae. Although this type does not produce harmful toxins, the decomposing matter could create low-oxygen conditions that negatively impact aquatic species ¹⁰¹.

Agriculture

The local agriculture industry is at risk due to warming temperatures and changing precipitation patterns. While the longer growing season due to warming temperatures could benefit farmers, increasing drought conditions, pests, and intense storms that damage crops or erode soil may offset any of the benefits and challenge the needed expansion of at-home food production and local agriculture.

According to the 2017 Census of Agriculture prepared by the United States Department of Agriculture, there are a total of 50,021 acres used for farm operations in Cumberland County, resulting in commodity totals of \$25,644,000, or \$512 per acre ¹⁰². In 2020, the Farm Services Administration issued an emergency declaration for Cumberland County as a result of prolonged, severe drought conditions, resulting in increased operational costs due to increased irrigation ¹⁰³.

Impacts in Freeport

Freeport has several hundred acres in farmland, including Wolfe's Neck Center, Frost Gully Farm, and Winter Hill Farm. Several agricultural parcels will experience an increase in inland flooding in 2050, however, the flooding will be minimal. The bigger climate threat to agriculture in Freeport will be from the changing precipitation patterns with heavy rains and prolonged periods of drought, along with warming temperatures which shifts the growing seasons and increases pests.

Although there will be little direct impact on Freeport since agriculture represents a small part of Freeport's land use and economy, the climate impacts to state, national, and international agriculture will be felt in town. This includes disruption to services, increase in cost, and an increase in food insecurity (discussed in further detail in the Community Services section). There are Community Gardens which residents may use to grow their own food. Community Garden plots are located at Wolfe's Neck and along Grove Street.

97 <https://indd.adobe.com/view/2f8cb7b4-5b37-4c50-8c4e-5aa0c92e1fa4>

98 <https://community-intertidal-data-portal-gpcog.hub.arcgis.com/apps/363d3a14c0f3480ca5992f0a4e6cb0da/explore>

99 <https://community-intertidal-data-portal-gpcog.hub.arcgis.com/apps/363d3a14c0f3480ca5992f0a4e6cb0da/explore>

100 <https://www.pressherald.com/2017/12/06/toxic-bloom-closes-casco-bay-shellfish-industry/>

101 <https://www.pressherald.com/2023/08/24/a-coffee-colored-algal-bloom-covers-the-gulf-of-maine/>

102 Cumberland County Hazard Mitigation Plan

103 Cumberland County Hazard Mitigation Plan

Forests and Carbon Sinks

Forests are key in combating the impacts of climate change as they sequester carbon dioxide through photosynthesis and improve air quality. However, as temperatures rise, precipitation events become more extreme, and invasive pests spread, Maine's forests face increasing challenges. Changes in temperature and precipitation are expected to increase stress and disturbances in forests. Disturbances such as flooding, ice storms and wildfires can open forest canopies, expose mineral soil, and reduce tree cover, providing greater opportunities for invasion ¹⁰⁴.

Forests currently cover nearly 89% of Maine and sequester over 60% of the state's annual carbon emissions, in addition to supporting the state-wide economy ¹⁰⁵. The full impacts of climate change on forests are variable as the longer spring and summer season will help spur growth, but warmer winters and decreased snowmelt will harm some forest species, particularly the spruce-fir forests ¹⁰⁶. Forests are not the only land cover to sequester carbon. Open grasslands, wetlands, and agricultural lands all store carbon. Particularly in Maine, coastal wetlands serve as a large natural carbon sink.

It will be important for towns to retain these natural areas to sequester carbon and minimize the impacts of climate change.

Impacts in Freeport

According to the NOAA Coastal Change Analysis Program Land Cover Atlas, between 1996 and 2016 Cumberland County lost 2.6% of forest land cover with almost 6 acres of loss being converted to developed land ¹⁰⁷. Based on NOAA's map, Freeport has similarly seen areas converted from forest cover to developed areas ¹⁰⁸.

Conserving forests and land cover that can act as carbon sinks can help provide an offset for greenhouse gas emissions. Future analysis should consider how much carbon sequestration currently exists in Freeport.

¹⁰⁴ Ryan, M.G., et.al. (2012). Effects of climatic variability and change. U.S. Department of Agriculture, Forest Service. ¹⁰⁶

¹⁰⁵ Fernandex, I., et. al. <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

¹⁰⁶ Fernandex, I., et. al. <https://climatechange.umaine.edu/wp-content/uploads/sites/439/2020/02/Maines-Climate-Future-2020-Update-3.pdf>

¹⁰⁷ <https://coast.noaa.gov/ccapatlas/>

¹⁰⁸ <https://coast.noaa.gov/ccapatlas/>

Table 10: Land cover change in Cumberland County from 1996 to 2016. Source: NOAA

Land Cover Class	1996 Area (sq miles)	2016 Area (sq miles)	Changes in Area (sq miles)
Emergency Wetland	15.65	15.39	-0.26
Woody Wetland	84.55	83.71	-0.84
Forested	549.63	535.42	-14.21
Agriculture	55.31	52.45	-2.86
Scrub/Shrub	15.41	21.09	5.68
Grassland	6.65	7.31	0.66

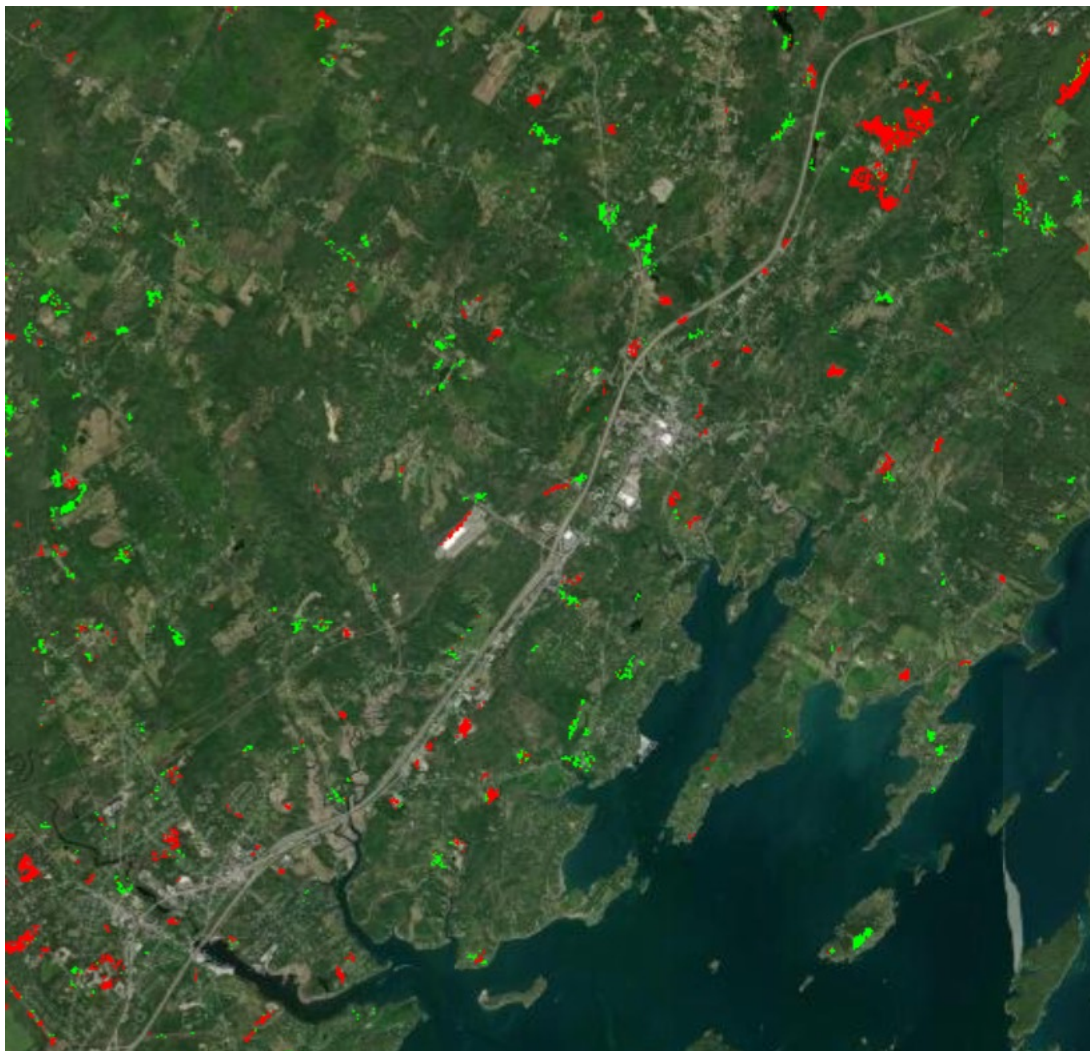


Figure 25: Change in forest cover where red symbolizes a loss of forest cover and green symbolizes an increase in forest cover. Source: NOAA

Land Cover

Climate vulnerability, resilience, and the ability to adapt are influenced by how we build and where we build. Existing development patterns and town regulations impact where the community may experience climate impacts today and, in the future. Areas of town with more impervious surface will experience higher temperatures, create more stormwater runoff, and decrease water quality ¹⁰⁹. Some of this can be offset by conserving open space and tree canopy. Creating “urban forests” such as planting street trees or maintaining pocket parks are effective ways to offset the urban heat island effect and reduce stormwater runoff ¹¹⁰.

Zoning ordinances are another tool town’s use to impact how the community develops. Zoning may be used to control building density, limit sprawl, or maintain green space in ways that reduce vulnerability or maximize the utility of resilient infrastructure ¹¹¹. For example, setting a shoreland overlay district creates restrictions on what and how close development can occur around bodies of water to protect water quality.

- **Land Cover:** *The vegetative characteristics of the land such as forest, wetland, impervious*
- **Land Use:** *Reflects how people use the land such as recreational, mixed use, or conservation.*
- **Zoning:** *Zoning ordinances impacts land use by limiting what developers and landowners can do with their properties*
- **Urban Forest:** *all trees within a densely populated area, including trees in parks, on streetways, and on private property*

In Freeport

Freeport is a built-out town with areas of high impervious surface but also large areas of tree canopy. The maps of impervious surface and tree canopy provide a proxy for understanding which areas of town may be most at risk.

¹⁰⁹ <https://www.usgs.gov/special-topics/water-science-school/science/impervious-surfaces-and-flooding#overview>

¹¹⁰ <https://www.fs.usda.gov/ccrc/topics/urban-forests-and-climate-change#:~:text=Urban%20forests%2Dlike%20any%20forest,use%20depending%20on%20their%20location>

¹¹¹ <https://toolkit.climate.gov/topics/built-environment/planning-and-land-use>

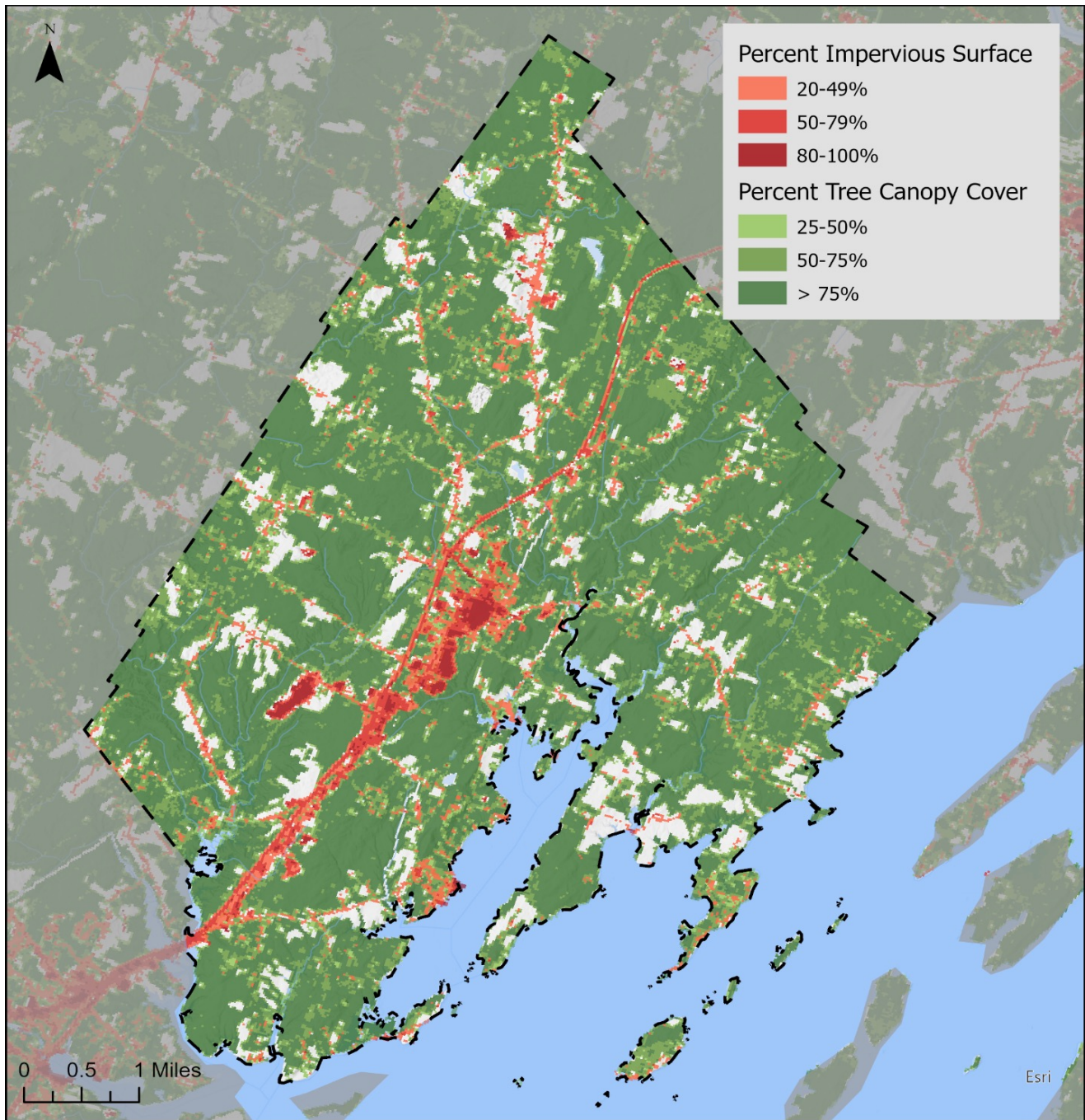


Figure 26: Percent coverage of tree canopy and impervious surface. Source: US National Land Cover Database

Freeport has a zoning ordinance which was last adopted in 2008, however it is amended on an almost yearly basis. However, the current zoning ordinance does not account for existing or projected climate hazards. The town will be starting an update to their Comprehensive Plan which will provide an additional analysis of their land use. To align with the Climate Action Plan, it is recommended that any zoning updates consider how future development will influence and be impacted by climate change. For example, a coastal resilience overlay ordinance would help protect critical assets from climate change threats such as sea level rise, flooding, and coastal erosion¹¹². In addition to the zoning code, Freeport has multiple ordinances that support resilience in the community — including Shoreland Zoning Ordinance. However, similar to the zoning code, these ordinances don't include climate considerations. Future planning documents and ordinances should consider going above baseline regulations and incorporate climate considerations. Specific recommendations will be included in the Climate Action Plan and Comprehensive Plan.

112 https://smpdc.org/vertical/Sites/%7B14E8B741-214C-42E2-BE74-5AA9EE0A3EFD%7D/uploads/Coastal_Resilience_Ordinance_Review_Report_SMPDC_Grant_Project.pdf

Priority Focuses and Areas

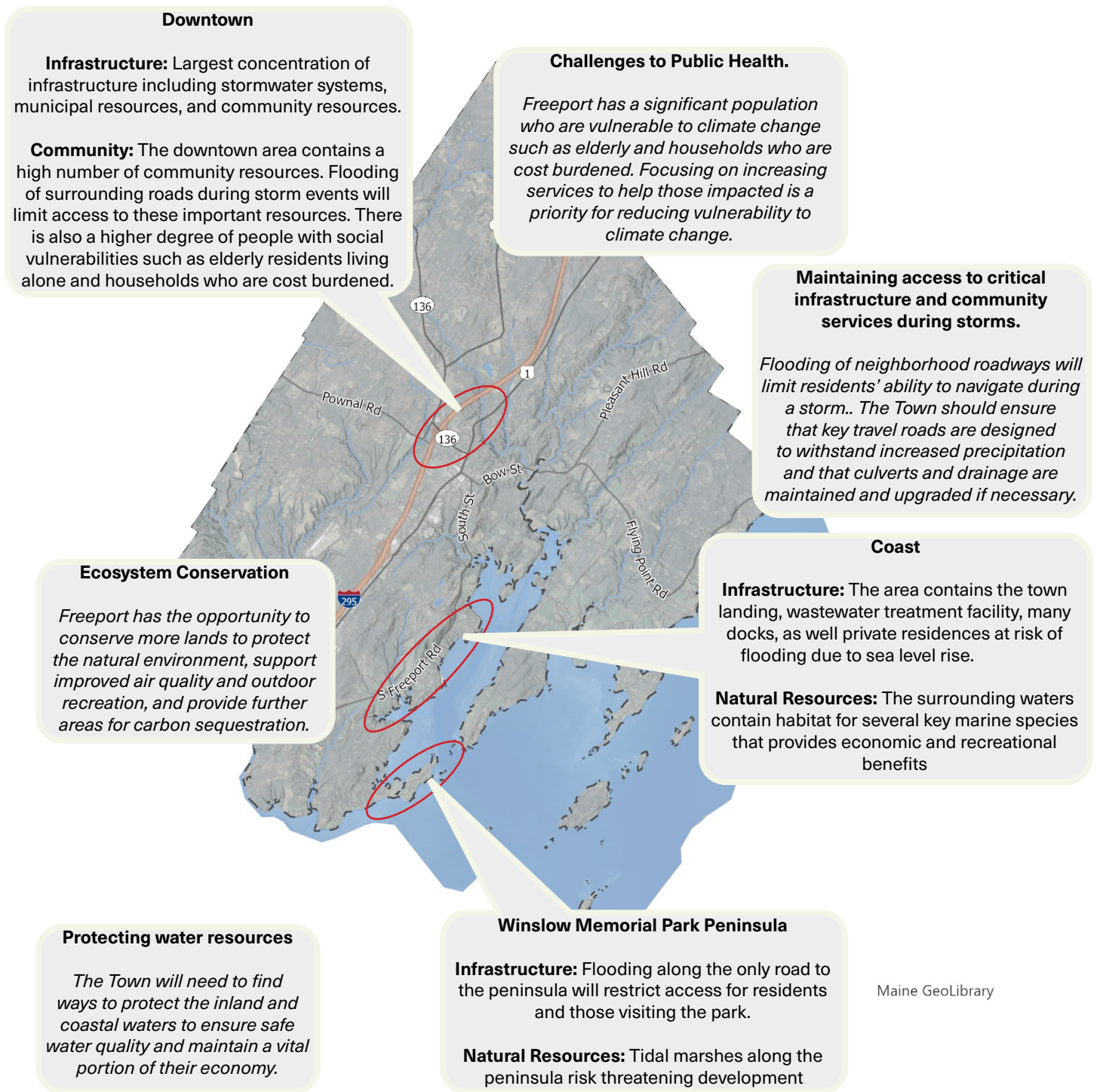


Figure 27: Priority areas of focus for addressing climate vulnerabilities

Freeport's elevated coastline and relatively low social vulnerability provides resilience to climate change. However, there are hazards and impacts that should be prioritized to enhance resilience to climate shocks. In this section those assets, communities, and geographic areas are highlighted.

- 1. Maintaining access to critical infrastructure and community services during storms** – Currently, the town experiences only moderate travel restrictions. However, with the increase in intense storms roads are more likely to experience flooding and high winds will damage infrastructure. Roadway flooding is dispersed around town due to the large number of waterways in town. This means that many neighborhood roads will be cut off, especially along dead-end streets and those not connected to the larger roadway network. Flooded or damaged transportation infrastructure can cut off emergency vehicles and limit access to important community resources. In addition, flooded infrastructure increases costs for maintenance and repair, disrupts supply chains, and creates barriers for habitat migration. The Town should ensure that key travel roads are designed to withstand increased precipitation and that culverts and drainage are maintained and upgraded if necessary.
- 2. Protecting water resources** – Currently, Freeport has impaired streams and restricted coastal waters. Rising ocean temperatures and acidity and more runoff from increased precipitation threaten to strain water resources even further. The Town will need to find ways to protect the inland and coastal waters to ensure safe water quality and maintain a vital portion of their economy.
- 3. Ecosystem Conservation** – Freeport residents enjoy their access to parks and open space. However, many of these natural areas are at risk due to climate change – flooding from sea level rise threatens tidal marshes and the surrounding development, inland flooding threatens conserved lands, and increasing temperatures bring invasive species. Freeport has the opportunity to conserve more lands to protect the natural environment, support improved air quality and outdoor recreation, and provide further areas for carbon sequestration.
- 4. Challenges to Public Health** – Climate change, particularly rising temperatures, is likely to exacerbate human-health impacts. Heat-related illnesses, asthma from worsened air quality, and vector-borne diseases are all likely to increase in the future. This will stress the healthcare system and impact people's mental health. Freeport has a significant population who are vulnerable to these changes such as elderly and young residents, and households who are cost burdened. Combined with rising unaffordability, these populations will have trouble adapting to future climate disasters. Focusing on increasing services and ensuring equitable access to resources to help those impacted is a priority for reducing vulnerability to climate change.

Geographic Priority Areas

This report presented information on how different assets are at risk from climate hazards. This section will look at how all of the resources interact within a geographic area to assess the areas of Freeport most vulnerable in Freeport. Identification and assessment of these areas included the following factors:

- Number of climate hazards threatening the area
- Number of assets in a specific area that are vulnerable to identified climate hazards
- Time before a hazard will significantly impact a geographic area's community, infrastructure, and natural resources
- Chance of natural system degradation
- Overlapping social vulnerability in observed neighborhoods

This assessment can guide prioritization of areas for future climate adaptation planning strategies.

Downtown

The combination of exposure to climate hazards, and infrastructure and social vulnerabilities puts this area at risk.

- **Climate Hazards:** Warming Temperatures—the area is more impervious than other neighborhoods putting it at risk of locally high temperatures compared to other greener areas.
- **Infrastructure:** The area contains the largest concentration of infrastructure including stormwater systems, municipal resources, and community resources such as Freeport Community Services. Maintaining access to this area will be critical to ensuring resilience during a climate event.
- **Community:** The downtown area contains a high number of community resources, including the town hall, the food pantry, and several schools. Flooding of surrounding roads during storm events will limit access to these important resources.
- **Social:** The downtown area has a higher degree of people with existing social vulnerabilities – particularly those who are cost burdened, older residents who live alone, and households without a vehicle. Higher impervious surface will impact the older population and the lack of vehicles and financial security could limit residents' ability to respond to a climate disaster.

Coastline along S Freeport Road and the Harraskeet River

The combination of exposure to climate hazards, and risks to infrastructure and natural resources puts this area at risk.

- **Climate Hazards:** Sea Level Rise—the area contains a lot of coastal infrastructure that can be at risk of flooding as sea levels rise.
- **Infrastructure:** The area contains the town landing, wastewater treatment facility, many docks, as well as private residences. These properties are at risk of flooding due to sea level rise while inland flooding may restrict their travel to evacuate.
- **Natural Resources:** The surrounding waters contain habitat for several key marine species that provides economic and recreational benefits.

Winslow Memorial Park Peninsula

The combination of exposure to climate hazards, and risks to infrastructure and natural resources puts this area at risk.

- **Climate Hazards:** Sea Level Rise – this peninsula will be cut off during flooding events and with rising sea levels.
- **Infrastructure:** Flooding along the only road to the peninsula will restrict access for residents and those visiting the park. In addition, there is a radio communication site on the peninsula that is vulnerable.
- **Natural Resources:** The surrounding waters contain habitat for several key marine species that provides economic and recreational benefits. Tidal marshes along the peninsula risk threatening development.