## Sea-Level Rise & Climate Change

### Inventory

*Introduction*

Climate change is already impacting Bowdoinham and poses significant threats to the community, including its beaches, natural resources, historical and cultural resources, infrastructure, people, and economy. Warming air and ocean temperatures; shifting precipitation patterns; more frequent and intense storm events; sea level rise; increasing risk of drought; habitat loss; reduced biodiversity; and increasing prevalence of vector-borne diseases such as Lyme are just some of the climate hazards and impacts facing the town.

Climate change will not only exacerbate existing hazards and issues, but also cause new risks and challenges for Bowdoinham. Intense precipitation events could cause more stormwater runoff, amplifying existing water quality problems. Increasing storm intensity and frequency will likely cause more power outages that last longer, disrupting the community's normal activities, impairing public safety, and straining local resources. Shifting terrestrial habitat conditions and warming temperatures could harbor the expansion of existing invasive species and enable the arrival of new invasive species, jeopardizing traditional recreation and fishing activities like snowmobiling and ice fishing. Extreme heat and drought will threaten public health, natural resources and agricultural production.

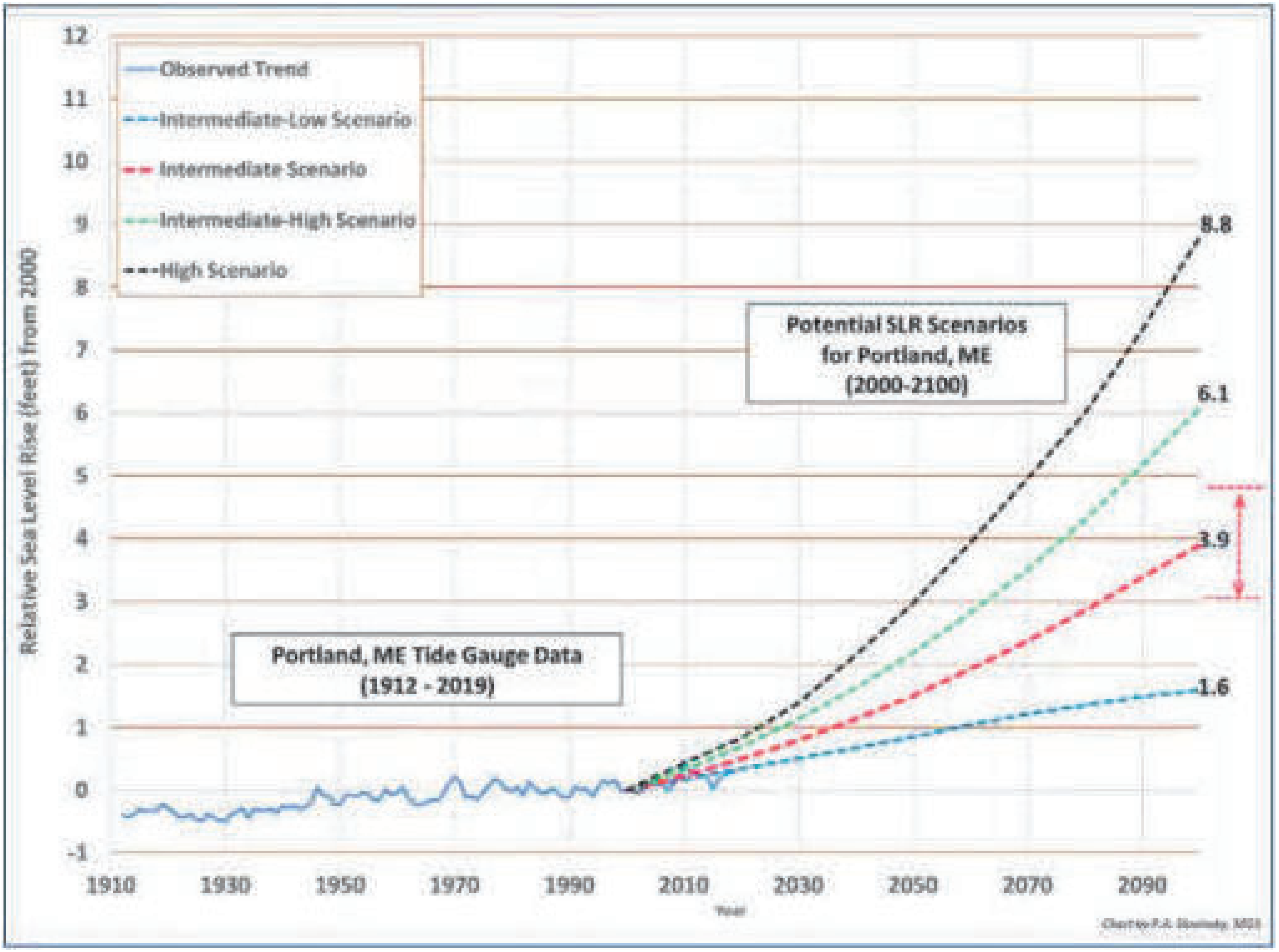
While climate change will likely impact every facet of the community in some way, those impacts will not be felt evenly across the community and will not be uniformly distributed among population groups. Individuals who already have increased social vulnerability or have been traditionally marginalized and underrepresented will be disproportionately affected by climate hazards, as they generally have lower capacity to prepare for, respond to, and recover from hazard events and disruptions. Those populations include children and older adults, households with lower or moderate incomes, individuals with preexisting health conditions, people of color, and those living alone. Bowdoinham has a relatively high percentage of older individuals (65+) living alone, characteristics that contribute to elevated social vulnerability as they tend to be associated with social isolation and decreased ability to prepare for and respond to storms, flooding, and other natural disasters. As a result, the community likely has an elevated level of vulnerability to natural hazards and climate impacts.

*(1) Trends in Sea Level Rise*

Sea level rise is a global phenomenon driven by two primary factors related to climate change: an increase in the volume of ocean water caused by the melting of land-based ice sheets and glaciers, and thermal expansion of seawater as it is warmed by increasing global temperatures. While sea level in Maine has been rising in the long-term, over the past few decades the rate of rise has accelerated. Nearly half of the locally documented sea level rise that has occurred over the past century has happened since 1993, representing a rapid increase in the rate of change. That rise increases the frequency of nuisance and high tide flooding, with southern Maine seeing four times as many nuisance flooding events over the last decade compared with the average of the past 100-years. According to a State 2020 study, under intermediate global greenhouse gas emissions scenarios there is a 67% probability that sea level will rise between 1.1 and 1.8 feet by 2050, and between 3.0 and

4.6 feet by the year 2100 relative to 2000 water levels. Further, those scenarios do not account for more intense rainfall expected from climate change in the region, which will exacerbate flooding.

**Historical Sea Level Rise in Portland**



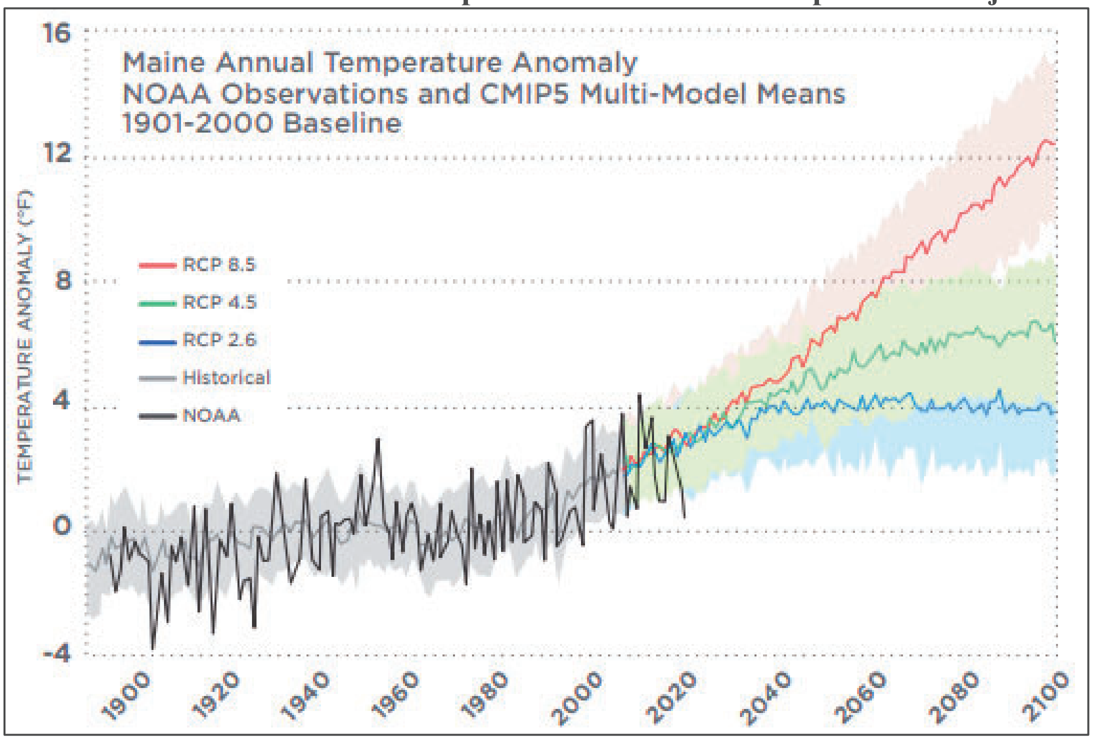

Source: Scientific Assessment of Climate Change and Its Effects in Maine prepared by the Maine Climate Council Scientific and Technical Subcommittee. P. Slovinsky, Maine Geological Society
Notes: Graph illustrating historical sea level rise in Portland (solid blue line) and scenarios from 2000-2100 with central estimates (50% probability of being met or exceeded) for low-intermediate to high sea level rise scenarios. The likely range of 3.0 to 4.6 feet (67% probability of sea level rise falling between these values) for the intermediate scenario is shown as a dashed red arrow and red lines on the right side of the figure. Values are presented in tenths of a foot and relate to a year 2000 starting point. Scenario data from the U.S. Army Corps of Engineers Sea Level Change Calculator based on sea level rise scenarios developed for the 4th U.S. National Climate Assessment.

*(2) Trends in Annual Temperature Rise*

From increasing land and ocean temperatures, to rising sea levels, more frequent severe storms, shortening winters and disrupted agricultural seasons, and more prevalent public-health risks, scientists have cataloged, and continue to catalog, the current and expected harms of climate change on Maine. Since 1895, Maine's statewide annual temperatures have risen by 3.2°F (1.8°C), with coastal areas warming more than the interior of the state. Of all the seasons, winters in Maine have warmed the most, which has caused Maine's agricultural growing season to increase by two weeks.

Acorriding to a 2020 study by the State, climate models suggest Maine may warm by an additional 2 to 4°F by 2050 and up to 10°F by 2100, depending on the success of curbing greenhouse gas emissions.

**Historical Trends in Maine's Temperature and Future Temperature Projections**




Source: State of Maine's 2020 Climate Action Plan, Maine Won't Wait.
Notes: Observed (black line) and model-projected (gray and colored lines) potential future temperature anomalies for Maine under different socio-economic/emissions scenarios (RCPs – Representative Concentration Pathways). Anomalies are the difference between the temperature in a particular year and the 1901-2000 baseline average.

Extreme heat days (days over ninety degrees) are expected to be 2-4 times more frequent in Maine by 2050, increasing the likelihood of heatwaves. Increasing temperatures and more high-heat days are putting people at risk, especially the elderly, those with health issues, or have limited access to home air conditioning. Extreme weather may cause injuries and deaths, outbreaks of waterborne diseases, and food borne illnesses following power outages, as well as mental health stress. Plant-based allergens have longer to affect Mainers during the year due to longer summers and shorter winters. The length of the pollen season and the amount of pollen produced will likely increase with rising temperatures and carbon dioxide concentrations. Asthma and hay fever are also likely to increase with climate change.

Further, nearly two-thirds of Maine's plants and animals, habitats, and at-risk species are either highly or moderately vulnerable to climate change. Warmer, shorter winters are contributing to increased tick-borne illnesses, such as Lyme disease. Tick abundance and disease risk are expected to increase with warming temperatures. If warming remains unchecked, our most sensitive plant and animal species on land and sea are expected to shift their ranges further north in pursuit of preferred environmental conditions.

*(3) Trends in Precipitation and Drought*

Trends in Maine's precipitation have become both heavier and more frequent. Maine Climate Council's Scientific Assessment of Climate Change and its Effects in Maine note that Maine's annual precipitation (rain and snow) has increased by more than six inches since 1895, whereas extreme precipitation events (over an inch in 24 hours) are becoming more frequent. More extreme weather events like nor'easters and hurricanes cause flooding, extreme wind, uprooted trees, and damage to infrastructure and buildings.

Further, the impact of less precipitation falling as snow results in changes in seasonal water-flow patterns and increases drought conditions. These conditions decrease the resilience of water resources and can negatively impact the quantity and quality of water supplies, agricultural operations, and ecosystem health. Drought conditions and increased winds also increase the risk of wildfire.

<u>Analysis</u>

*This section was prepared by JT Lockman, Catalysis Adaptation Partners, LLC, for the Town of Bowdoinham through a grant from the Maine Coastal Program, funding provided by National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Peter Slovinsky, Marine Geologist for Maine Geological Survey, Department of Agriculture, Conservation and Forestry created the data and maps showing the potential effects of sea level rise in Bowdoinham.*

*Vulnerability Assessment –*
*Sea Level Rise Impacts on Roads, Rails, Buildings, Tidal Marshes, and Land Use*

The Maine Geological Survey (MGS) prepared a vulnerability assessment for the Town of Bowdoinham, predicting how many miles of roads and railroads, and the number of buildings that might be flooded by sea level rise alone, in the coming decades. MGS also predicted these impacts to roads, railroads, and buildings, if a 100-year storm occurred, on top of the risen sea level, in the coming decades.

Storms of varying strengths are described in terms of their probability of occurrence. A 100-year storm is defined as a storm that has a one in a hundred chance of occurring in any given year, also known as a "1% storm". It does not necessarily mean that such a storm will occur only once every 100 years. (With bad luck, such storms can arrive closer together in time.) In the flood insurance studies published for towns by the Federal Emergency Management Agency (FEMA), the overall water height is predicted for the 100-year storm, which is called the "Base Flood Elevation," or BFE.

The analysis started by determining the height of the highest tide of the year that occurs today and using that as the starting point for the assessment. Table 1 shows, in the first row, that the highest tide of the year occurring today in Bowdoinham is 7.5 feet above Mean Lower Low Water (MLLW). The 1% storm water elevation from the Town's effective FEMA flood study is 13.2 feet MLLW. With 3.3 feet of sea level rise (1 m), the highest annual tide would reach 10.8 feet, and the 1% storm would reach 16.5 feet. The table below summarizes the various water heights that would occur with different amounts of sea level rise during the highest annual tide of the year (the Spring Tide) and with a 1% storm. It should be noted that we used the current flood study height for the 1% storm, when looking into the future. It is probable that every 15 to 20 years, FEMA will update its flood study for Bowdoinham, into the future.

**Table :1 Heights of the Highest Annual Tide with 1% Storm, at Different Amounts of Sea Level Rise**

| Level Rise Scenario | Planning Timeframe | Highest Annual Tide* | 1% storm ** |
|---|---|---|---|
| **Existing (2013)** | Current | 7.5 | 13.2 |
| **1 foot (0.3 m)** | 2050 | 8.5 | 14.2 |
| **2 feet (0.6 m)** | 2100 | 9.5 | 15.2 |
| **3.3 feet (1.0 m)** | 2100 | 10.8 | 16.5 |
| **6 feet (1.8 m)** | 2100+ | 13.5 | 19.2 |

*All elevations referenced to feet, above Mean Lower Low Water (MLLW).*
** HAT data derived from the nearest NOS tidal prediction stations (Cathance River, 7.5 ft MLLW and Sturgeon Island 6.9 ft MLLW); only Cathance River data shown.*
*** 1% storm data is taken from the community's effective FEMA Flood Insurance Study, dated 11/19/1997; this is 9.4 ft NGVD, or 8.7 ft NAVD.*
*The NOAA VDATUM tool was used to convert NAVD to MLLW datum*

Source: Peter Slovinsky, MGS, POSM project, 2013

Further, a GIS analysis (Geographic Information Systems, or computer mapping) was conducted to estimate the impacts to roads, railroads, and buildings, associated with these higher water levels. These are general estimates based solely on the current building stock and current road and rail network and are suitable for planners to understand the relative changes in impacts at varying states of sea level rise and storm surge.

There are 85.6 miles of roads and 10.3 of rails in the Town of Bowdoinham. This table shows the mileage of roads and rails that would be flooded, as well as the percentage of total road and rail miles flooded, with different levels of sea level rise on top of the Highest Annual Tide.

**Table 2: Road and Rail Infrastructure Affected by Sea Level Rise Alone**

| Scenario (HAT) | Impacted Roads | | Impacted Rails | |
|---|---|---|---|---|
| | **Miles** | **% impacted*** | **Miles** | **% impacted*** |
| **Existing Conditions** | 0.0 | 0.0% | 0.0 | 0% |
| **0.3 m (1 foot) SLR** | 0.0 | 0.0% | 0.0 | 0% |
| **0.6 m (2 feet) SLR** | 0.0 | 0.0% | 0.0 | 0% |
| **1.0 m (3.3 feet) SLR** | 0.2 | 0.2% | 0.0 | 0% |
| **1.8 m (6.0 feet) SLR** | 1.8 | 2.1% | 0.3 | 3% |

**impacted means the road or rail is covered by water*

Source: Peter Slovinsky, MGS, POSM project, 2013

The next step in the analysis was to model how much flooding might occur, when a 1% storm came on top of sea level rise. This table shows the mileage of roads and rails that would be flooded, as well as the percentage of total road and rail miles flooded, with a 1% storm on top of different levels of sea level rise.

**Table 3: Road and Rail Infrastructure Affected by a 1% Storm on Top of Sea Level Rise**

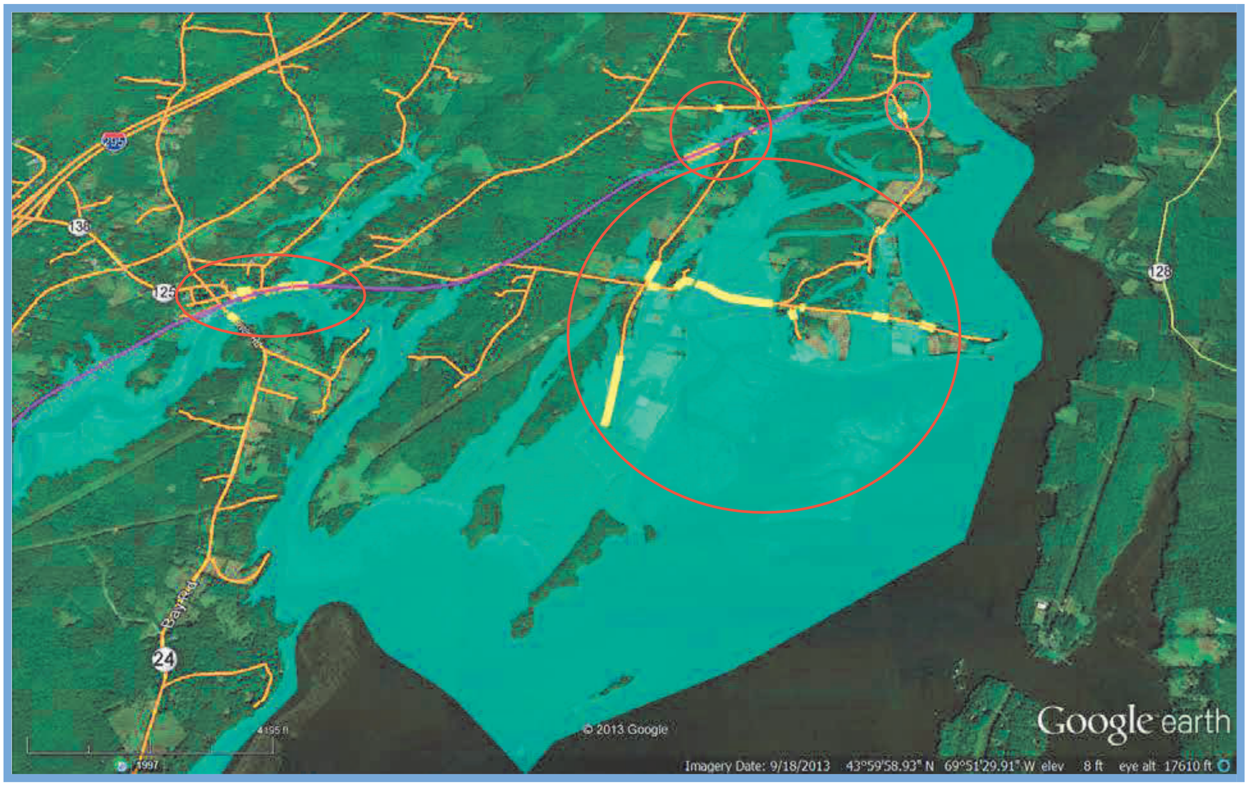
| Scenario (1% storm) | Miles of Impacted Roads and Rails | | | |
|---|---|---|---|---|
| | **Road Miles** | **% impacted*** | **Rail Miles** | **% impacted*** |
| **Existing Conditions** | 1.0 | 1.2% | 0.1 | 1% |
| **0.3 m (1 foot) SLR** | 1.8 | 2.1% | 0.3 | 3% |
| **0.6 m (2 feet) SLR** | 2.2 | 2.6% | 0.7 | 7% |
| **1.0 m (3.3 feet) SLR** | 3.4 | 4.0% | 1.5 | 15% |
| **1.8 m (6.0 feet) SLR** | 5.1 | 6.0% | 2.9 | 28% |

**impacted means the road or rail is covered by water*

Source: Peter Slovinsky, MGS, POSM project, 2013

The following figures, illustrate the locations of predicted future road and rail inundations, as summarized in Tables 2 and 3. Each of the figures represents predicted flooding for a scenario of either sea level rise alone, or a 1% storm heightened by sea level rise, by a future date. It should be noted that no figures were provided below for the year 2025, as only 6 inches of sea level rise is expected by that date, and no impacts were predicted that would be visible at this scale.

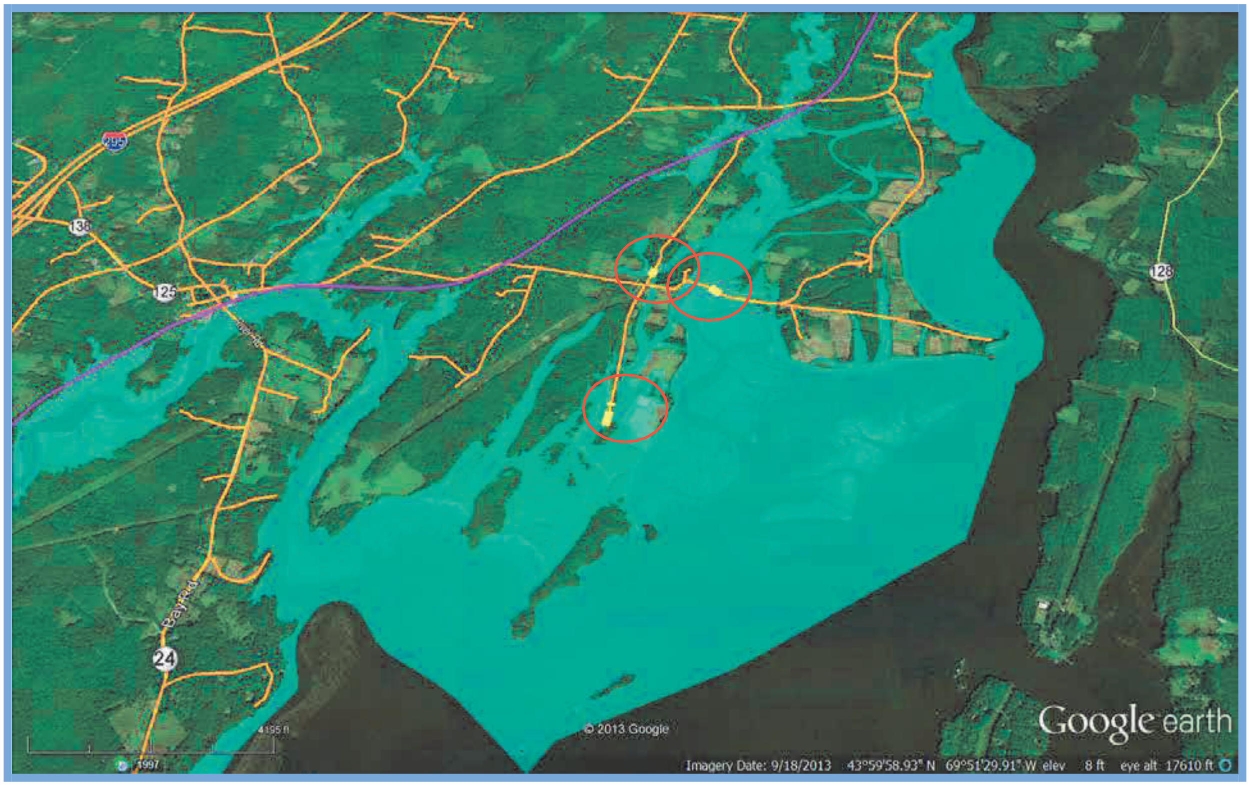
**Figure 1: 2050 Predicted Road and Rail Inundation with 1 foot of Sea Level Rise and 1% Storm**




Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2050 Predicted Road and Rail Inundation with 1 foot of Sea Level Rise and Storm Surge from a 1% Storm, illustrating Table 3, row 2. Total Water Elevation = 14.2 feet above MLLW.

**Legend:**
Purple Line – Railroad
Orange Lines – Road Network, from E-911
Yellow Segments – Inundated Roads
Orange Segments – Inundated Rails
Red Circles – Areas around inundation
Blue Shade – Extent of Flooding

**Figure 2: 2100 Predicted Road and Rail Inundation with 3.3 feet of Sea Level Rise Only**



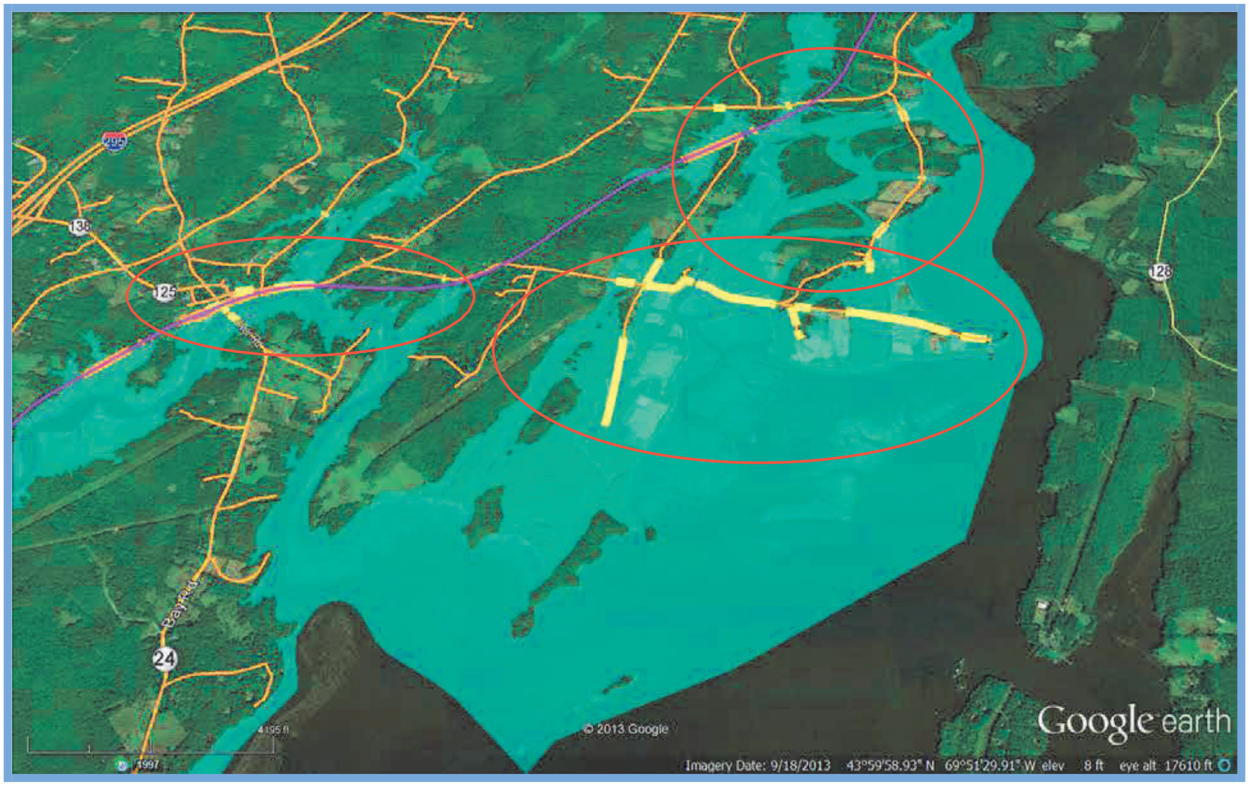

Source: Peter Slovinsky, MGS, POSM project, 2013

Notes: 2100 Predicted Road and Rail Inundation with 3.3 feet (1 m) of Sea Level Rise Alone, illustrating Table 2, row 4. Total water level = 10.8 feet above MLLW.

**Legend**

Purple Line – Railroad
Orange Lines – Road Network, from E-911
Yellow Segments – Inundated Roads
Orange Segments – Inundated Rails
Red Circles – Areas around inundation
Blue Shade – Extent of Flooding

**Figure 3: 2100 Predicted Road and Rail Inundation with 3.3 feet of Sea Level Rise and Storm Surge from a 1% Storm**




Source: Peter Slovinsky, MGS, POSM project, 2013
*Notes:* Figure 11: 2100 Predicted Road and Rail Inundation with 3.3 feet (1 m) of Sea Level Rise and Storm Surge from a 1% Storm, illustrating Table 3, row 4. Total water level = 16.5 feet above MLLW.

**Legend**
Purple Line – Railroad
Orange Lines – Road Network, from E-911
Yellow Segments – Inundated Roads
Orange Segments – Inundated Rails
Red Circles – Areas around inundation
Blue Shade – Extent of Flooding

The next step of the MGS analysis was an estimate of the number of buildings affected by sea level rise and future storm surges. Table 4 indicates the number of buildings whose center points would be flooded by the highest annual tide (HAT) with varying amounts of sea level rise, as well as how many would be flooded if a 1% storm in the future, came on top of sea level rise.

**Table 4: Number of Buildings Affected by Sea Level Rise Alone; by Sea Level Rise on Top of a 1% Storm**

**Number of Buildings Impacted***

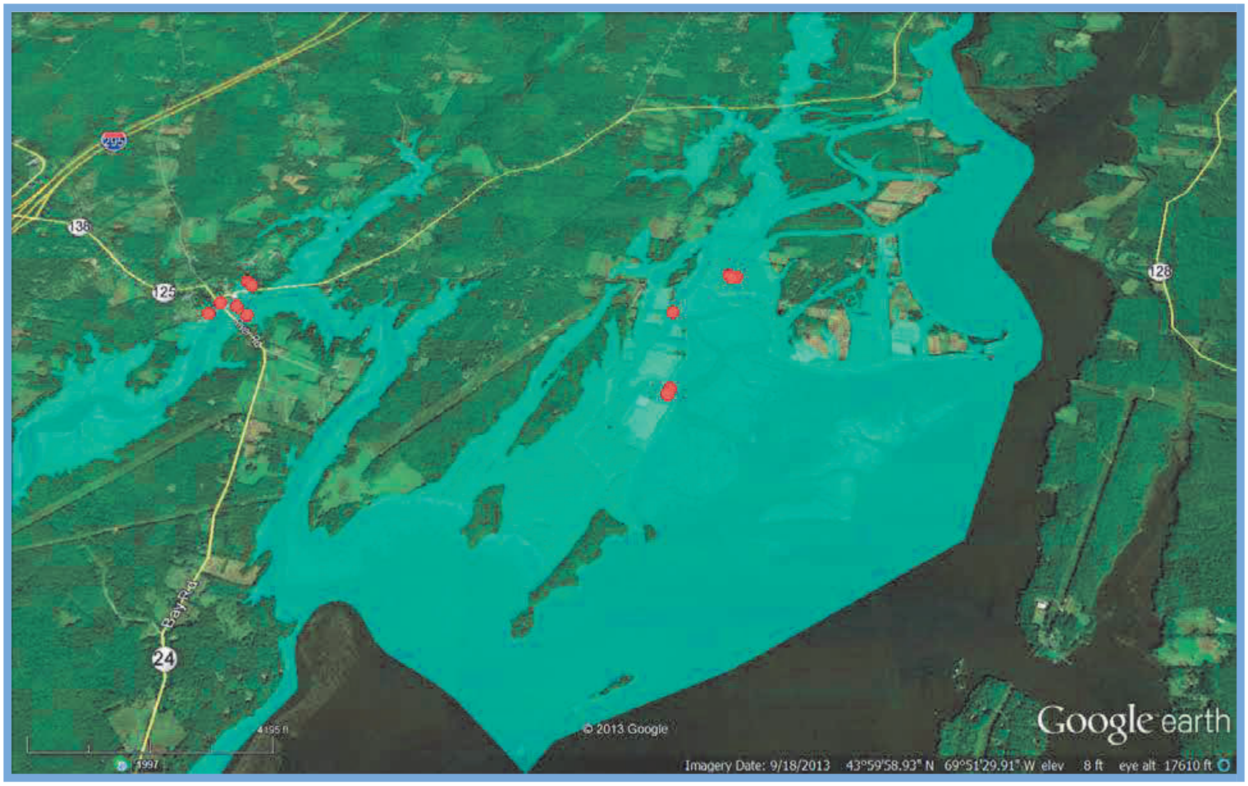
| Scenario of Sea Level Rise on Top of the Highest Annual Tide (HAT) | By HAT only | By the 1% storm |
|---|---|---|
| **Existing Conditions** | 0 | 7 |
| **0.3 m (1 foot) SLR** | 0 | 12 |
| **0.6 m (2 feet) SLR** | 0 | 14 |
| **1.0 m (3.3 feet) SLR** | 4 | 23 |
| **1.8 m (6.0 feet) SLR** | 12 | 46 |

**impacted means the building point is intersected by water*

Source: Peter Slovinsky, MGS, POSM project, 2013

Figures 4 through 6 below, illustrate the building impacts from Table 4.

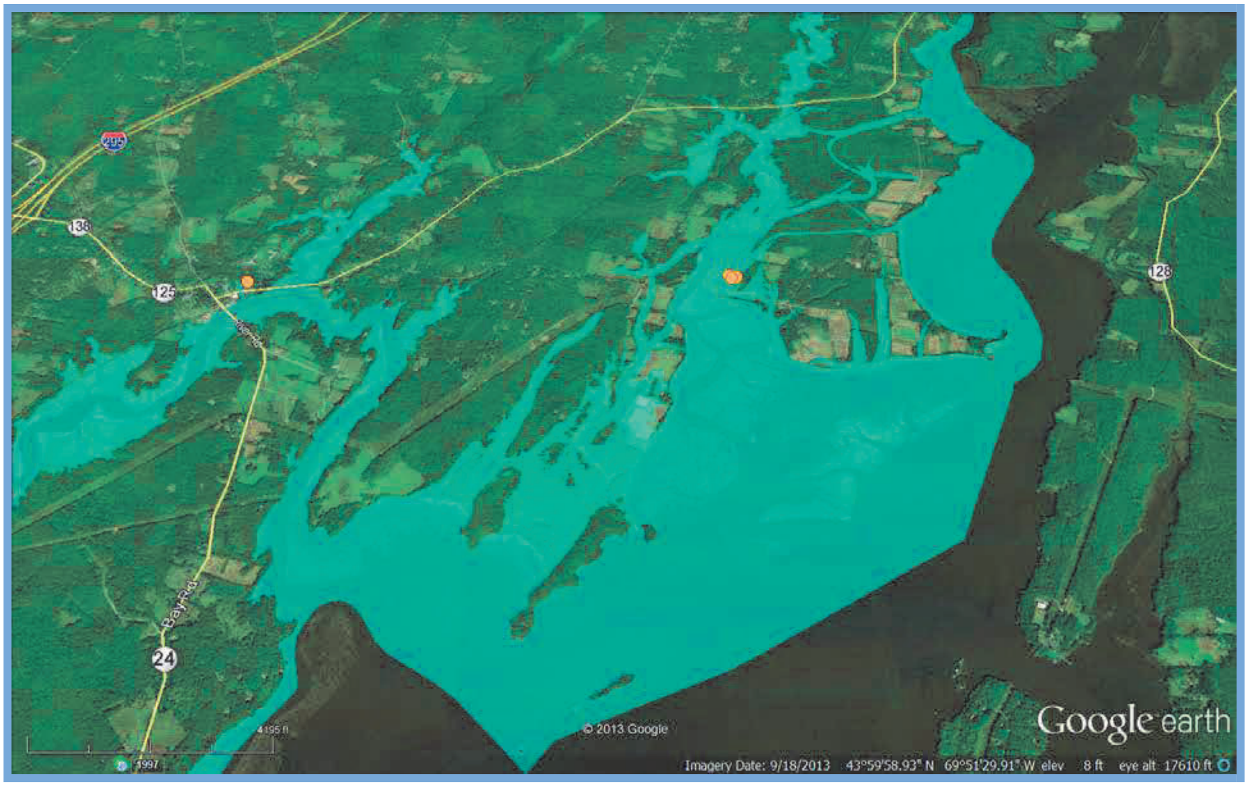
**Figure 4: 2050 Predicted Building Inundation with 1 foot of Sea Level Rise and Storm Surge from a 1% Storm**




Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2050 Predicted Building Inundation with 1 foot of Sea Level Rise and Storm Surge from a 1% Storm, illustrating Table 4, row 2. Total Water Elevation = 14.2 feet above MLLW.

**Legend**
Red Dots – Center Points of Buildings Inundated
Blue Shade – Extent of Flooding

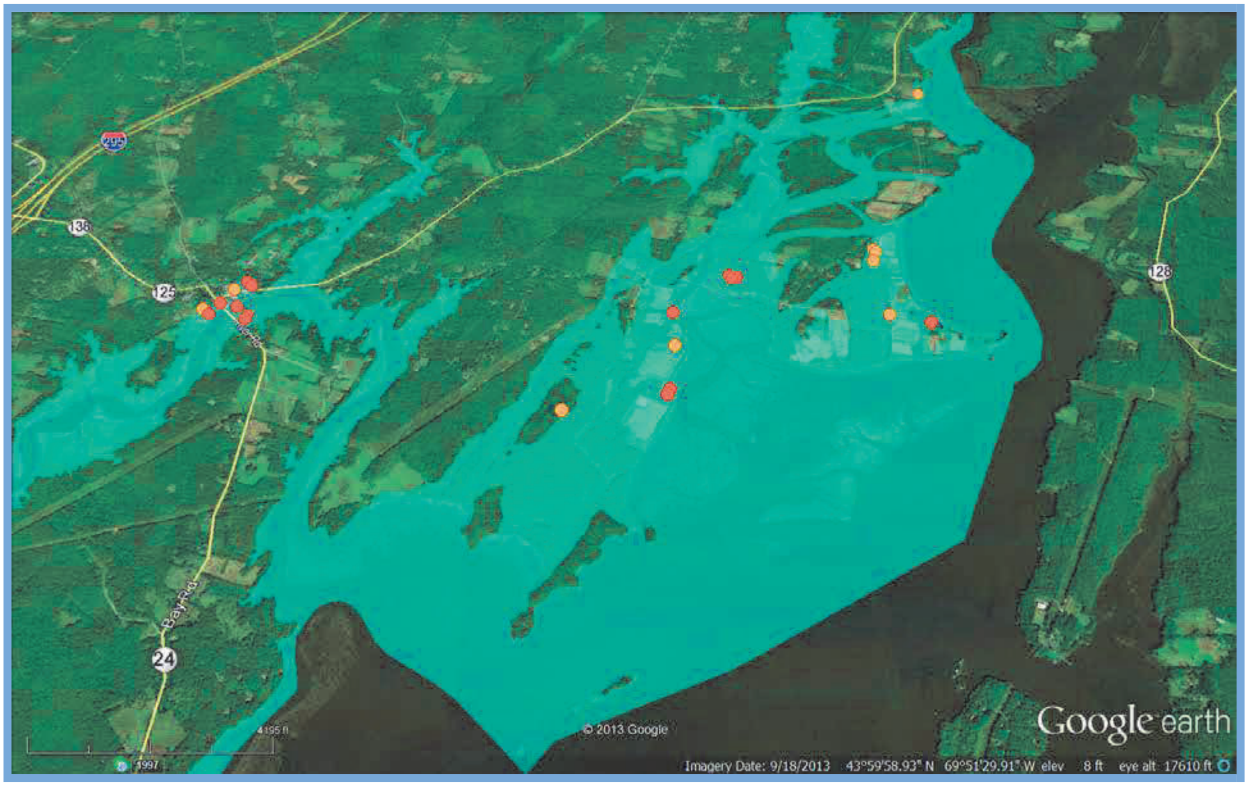
**Figure 5: 2100 Predicted Building Inundation with 2 to 3.3 feet of Sea Level Rise Only**




Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2100 Predicted Building Inundation with 2 to 3.3 feet (0.6 - 1 m) of Sea Level Rise Alone, illustrating Table 4, rows 3 & 4, column 1. Total Water Elevation = 10.8 feet above MLLW.

**Legend**
Orange Dots – Center Points of Buildings Inundated Blue Shade – Extent of Flooding

**Figure 6: 2100 Predicted Building Inundation with 2 to 3.3 feet of Sea Level Rise and Storm Surge from a 1% Storm**




Source: *Peter Slovinsky, MGS, POSM project, 2013*
Notes: 2100 Predicted Building Inundation with 2 to 3.3 feet (0.6 – 1 m) of Sea Level Rise and Storm Surge from a 1% Storm, illustrating Table 4, rows 3 & 4, column 2. Total Water Elevation =16.5 feet above MLLW.

**Legend**
Orange Dots - Center Points of Buildings Inundated by 3.3 feet of Sea Level Rise (SLR) with a 1% Storm
Red Dots - Center Points of Buildings Inundated by 2 feet of SLR with a 1% Storm
Blue Shade – Extent of Flooding

In the next step of the assessment, MGS predicted the effect of sea level rise on tidally influenced marshes in Bowdoinham. Marshes serve many important functions, including nurseries for fish and other aquatic species, as habitat for birds, and as reservoirs that slow down and store stormwater during storm events. Furthermore, it has been shown that healthy salt marshes can provide other ecological benefits, such as filtering pollutants and sediments that run off from adjacent uplands.

Table 5 shows the acreage of lands adjacent to today's tidal marshes that may be expected to convert to marsh, as sea level rises. If the marshes of today are allowed to flood higher as sea level increases, and are not obstructed by walls, roads, or fill, they will naturally attempt to migrate landward, and continue to provide ecological services as habitat for aquatic life and birds, and as reservoirs for flood control, and as filters for sediments and pollutants.

**Table 5: Estimates of Acres of Land, Adjacent to Today's Tidal Marshes, that May Convert to Tidally-Influenced Marsh, with Various Levels of Sea Level Rise**

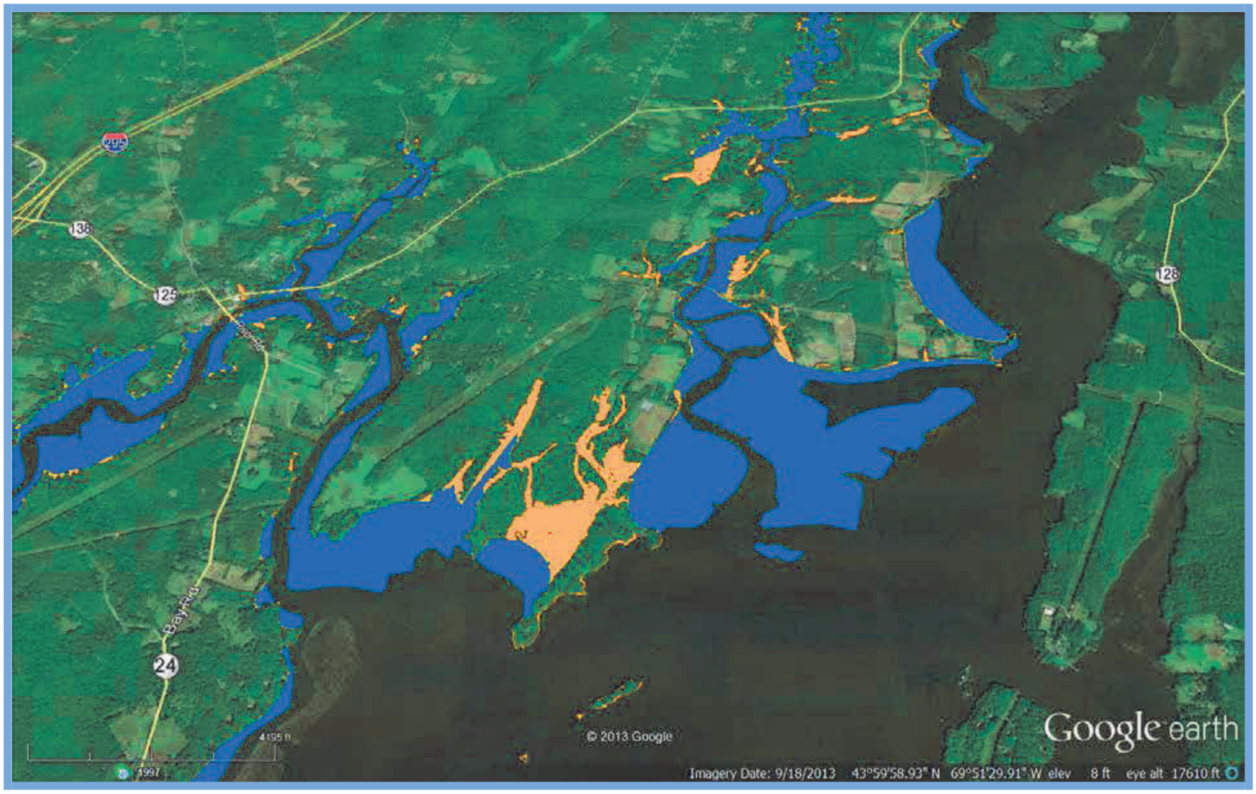
| Scenario | Estimated Potential Expansion Area Of Tidal Marshes (acres) | Cumulative Potential Expansion Area |
|---|---|---|
| **Existing Conditions** | N/A | N/A |
| **0.3 m (1 foot) SLR** | 292 | 292 |
| **0.6 m (2 feet) SLR** | 187 | 479 |
| **1.0 m (3.3 feet) SLR** | 276 | 755 |
| **1.8 m (6.0 feet) SLR** | 520 | 1275 |

** based on tidal elevations for each SLR scenario*

Source: Peter Slovinsky, MGS, POSM project, 2013

Figures 7 and 8 below illustrate the results in Table 5.

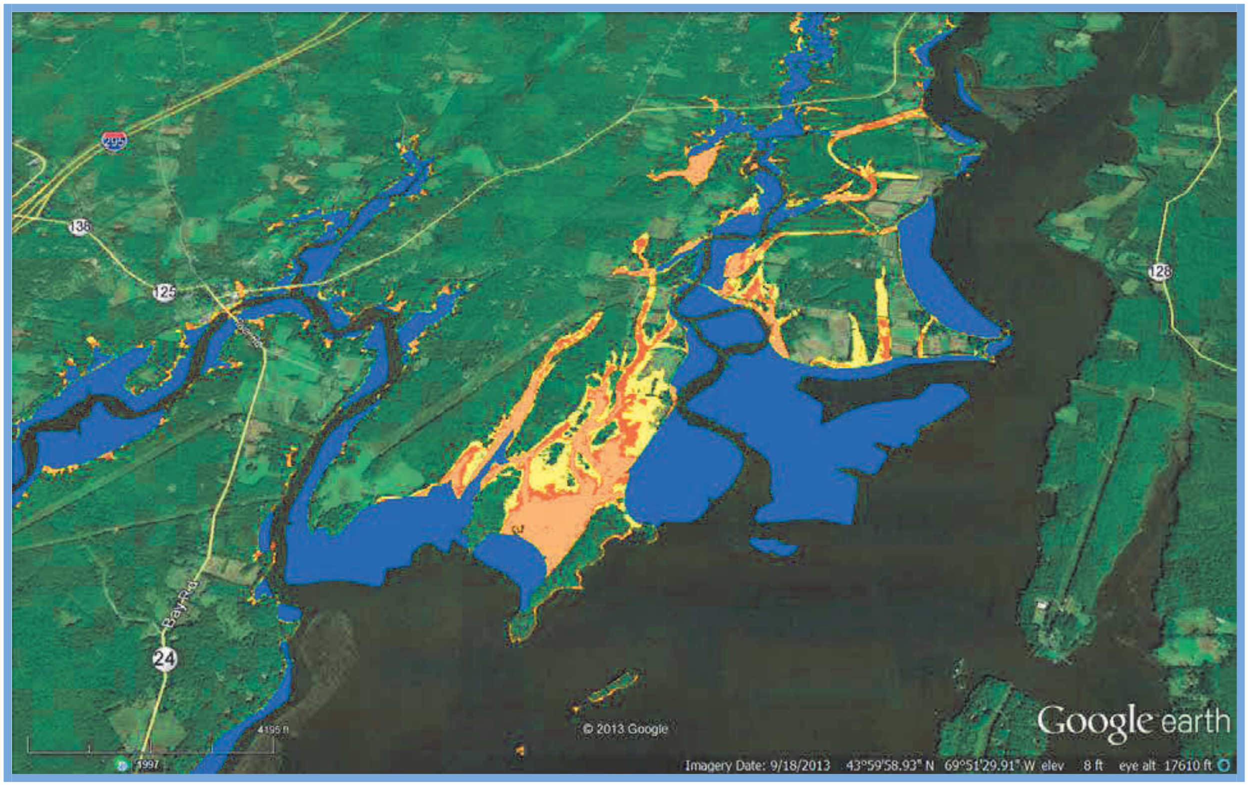
**Figure 7: 2050 Predicted Tidal Marsh Expansion with 1 foot of Sea Level Rise**




Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2050 Predicted Tidal Marsh Expansion with 1 foot of Sea Level Rise, illustrating Table 5, row 2. Total Water Level = 8.5 feet above MLLW.

**Legend**
Dark Blue – Current Extent of Tidal Marshes
Gold – Predicted Expansion Area of Marsh with 1 foot of Sea Level Rise

**Figure 8: 2100 Predicted Tidal Marsh Expansion with up to 3.3 feet of Sea Level Rise**




Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2100 Predicted Tidal Marsh Expansion with up to 3.3 feet (1 m) of Sea Level Rise, illustrating Table 5, rows 3 & 4. Total Water Level = 10.8 feet above MLLW.

**Legend**
Dark Blue – Current Extent of Tidal Marshes
Gold – Predicted Expansion Area of Marsh with 1 foot of Sea Level Rise
Brown - Predicted Expansion Area of Marsh with 2 feet of Sea Level Rise
Yellow - Predicted Expansion Area of Marsh with 3.3 feet (1 m) of Sea Level Rise

Finally, in the last step of the assessment, MGS measured the change in general land use, with predicted sea level rise. The State classified all land into 3 very basic categories: Natural, Agricultural, and Developed. In Bowdoinham, land in the natural category would usually be woods, brushy areas, and marshes. Land in the Agricultural Category would be farm fields, and Developed Land would include buildings, yards, paved areas, and roads. Table 6 below, summarizes expected losses of these three land cover types, as the highest annual tide increases with sea level rise. Figures 17 and 18 illustrate the results of Table 6.

**Table 6: Predicted Loss of Land Cover, by Type, with Various Amounts of Sea Level Rise.**

| Sea Level Rise Scenario | Planning Timeframe | Losses of Maine Land Cover Type (acres)* | | | |
|---|---|---|---|---|---|
| | | Natural | Agricultural | Developed | Total |
| **1 foot (0.3 m)** | 2050 | 278.1 | 6.3 | 1.7 | 286.1 |
| **2 feet (0.6 m)** | 2100 | 166.3 | 15.4 | 2.6 | 184.3 |
| **3.3 feet (1.0 m)** | 2100 | 230.1 | 38.2 | 6.0 | 274.3 |
| **6.0 feet (1.8 m)** | 2100+ | 413.2 | 83.4 | 20.8 | 517.4 |

*Maine Land Cover Data included 21 different types which were grouped into 3 dominant types for this study*
**acreage differs from estimated wetland expansion areas due to some areas not being classified by MELCD*

Source: Peter Slovinsky, MGS, POSM project, 2013

**Figure 9: 2050 Predicted Inundation of Natural, Agricultural, and Developed Lands with 1 foot of Sea Level Rise Alone**


Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2050 Predicted Inundation of Natural, Agricultural, and Developed Lands with 1 foot of Sea Level Rise Alone, illustrating Table 6, row 1. Total Water Level = 8.5 feet above MLLW.

**Legend**
Light Green – Inundated Natural Areas

**Figure 10: 2100 Predicted Inundation of Natural, Agricultural, and Developed Lands with 3.3 feet of Sea Level Rise Alone**

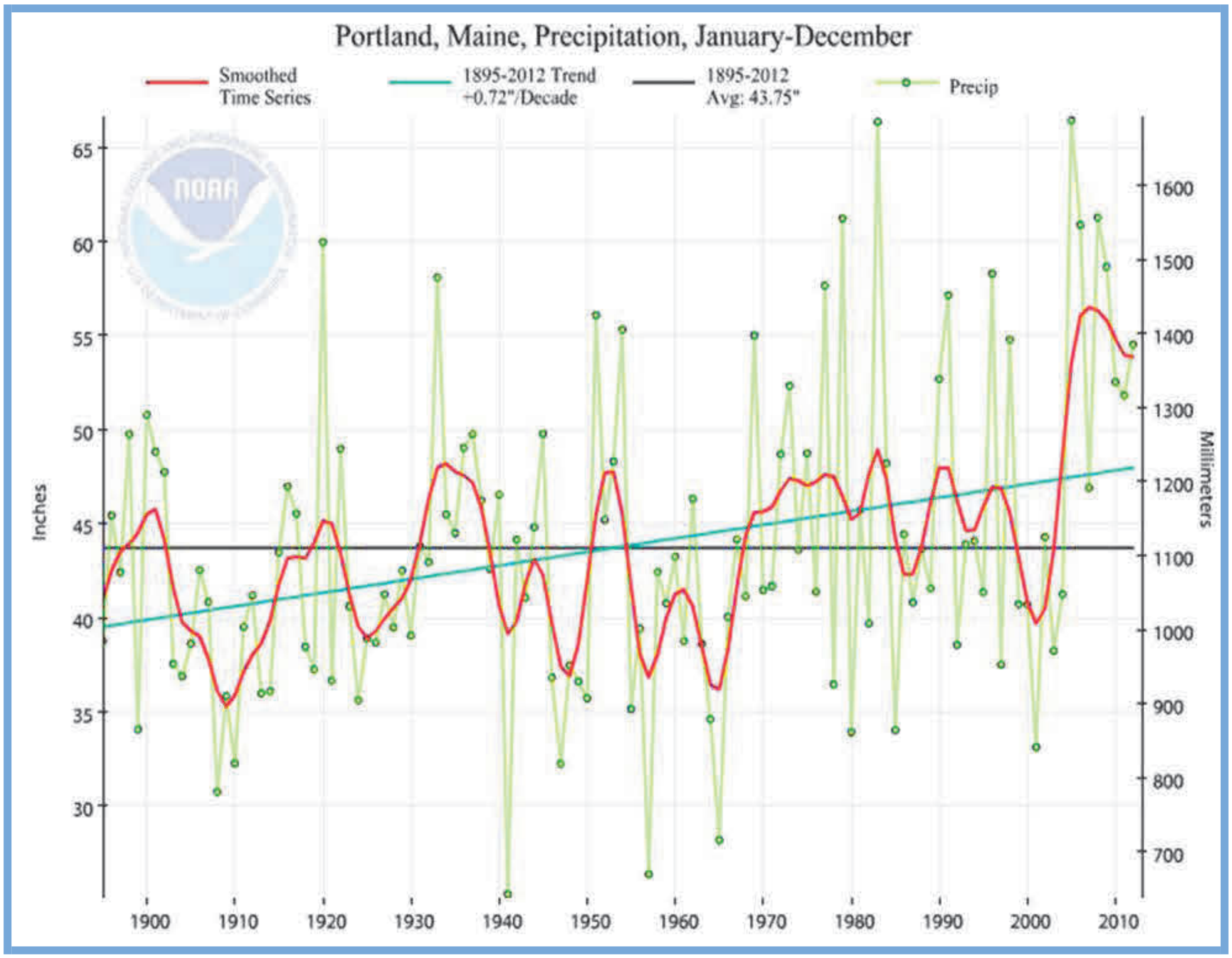

Source: Peter Slovinsky, MGS, POSM project, 2013
Notes: 2100 Predicted Inundation of Natural, Agricultural, and Developed Lands with 3.3 feet (1.0 m) of Sea Level Rise Alone, illustrating Table 6, rows 2 & 3. Total Water Level = 10.8 feet above MLLW.

**Legend**
Light Green – Inundated Natural Areas
Dark Green – Inundated Agricultural Lands
Red – Inundated Developed Areas including Roads

*Climate Change and Increased Precipitation*

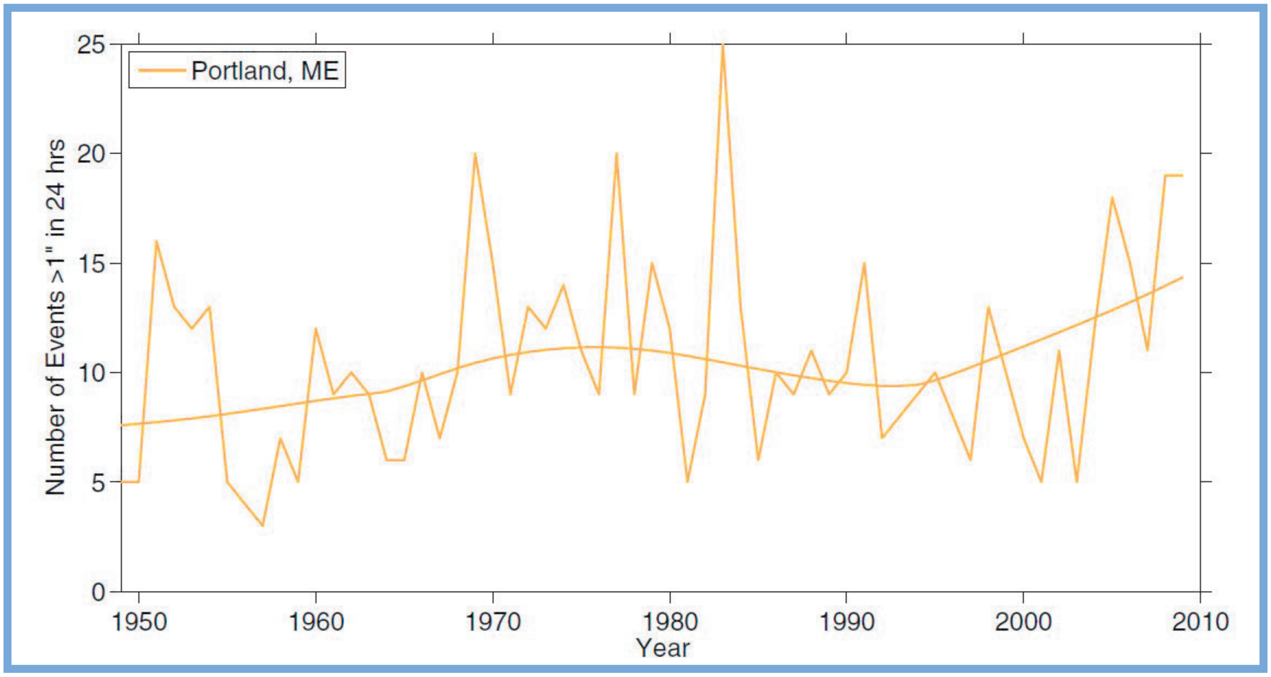
The next figures in this chapter, Figure 11 & 12, show that water level increases from sea level rise are not the only component that will affect potential flooding conditions in the Town of Bowdoinham. It appears in the rainfall records that there is a trend for higher and more intense rain events that has started in the last twenty to thirty years. Both the annual amount of rain, and the number of rain storms with greater than one inch of rain in 24 hours have increased. The higher levels of rainfall are expected to increase damage experienced in future storms, when combined with the negative effects of sea level rise.

**Figure 11: Record of Increasing Annual Precipitation for Portland, Maine**




Source: P. Slovinsky, MGS. From NOAA Data through Dec. 31, 2012.

**Figure 12: Increasing Number of Rain Events Per Year, Greater than 1 inch, in a 24-Hour Period, for Portland, Maine**




Source: Climate Change in the Piscataqua/Great Bay Region: Past, Present, and Future Carbon Solutions New England, Cameron Wake, et al., December 2011.

When engineers have designed roads, culverts, and bridges in the last 50 years or so, they have used the "Rainfall Frequency Atlas of the United States," known as Technical Paper #40, published by the US government. A page from the Atlas is shown in Figure 21 below, shows that in Bowdoinham, the 24-hour rainfall that could be expected from a 1% storm would be 6.3 inches. Because of all the observations that annual rainfall has gone up, as well as the intensity of 24-hour storms, Cornell University's Northeast Regional Climate Center has recently completed an update of the Technical Paper #40 (TP-40). This new update indicates that the 24- hour rainfall that could be expected from a 1% storm would now be 7.62 inches, which is about a 20% increase. What this means as a practical matter, is that any bridge, culvert, or drain in Bowdoinham, which was designed to handle the amount of rain in the TP-40, is probably sized 20% too small to handle a 1% percent, 24-hour rainfall that might occur at any time. For this reason alone, any infrastructure that conveys or crosses water should be considered for an upgrade, when it is going to be replaced.

**Figure 13: New England Area, from the Rainfall Frequency Atlas of the United States, Technical Paper No. 40.**

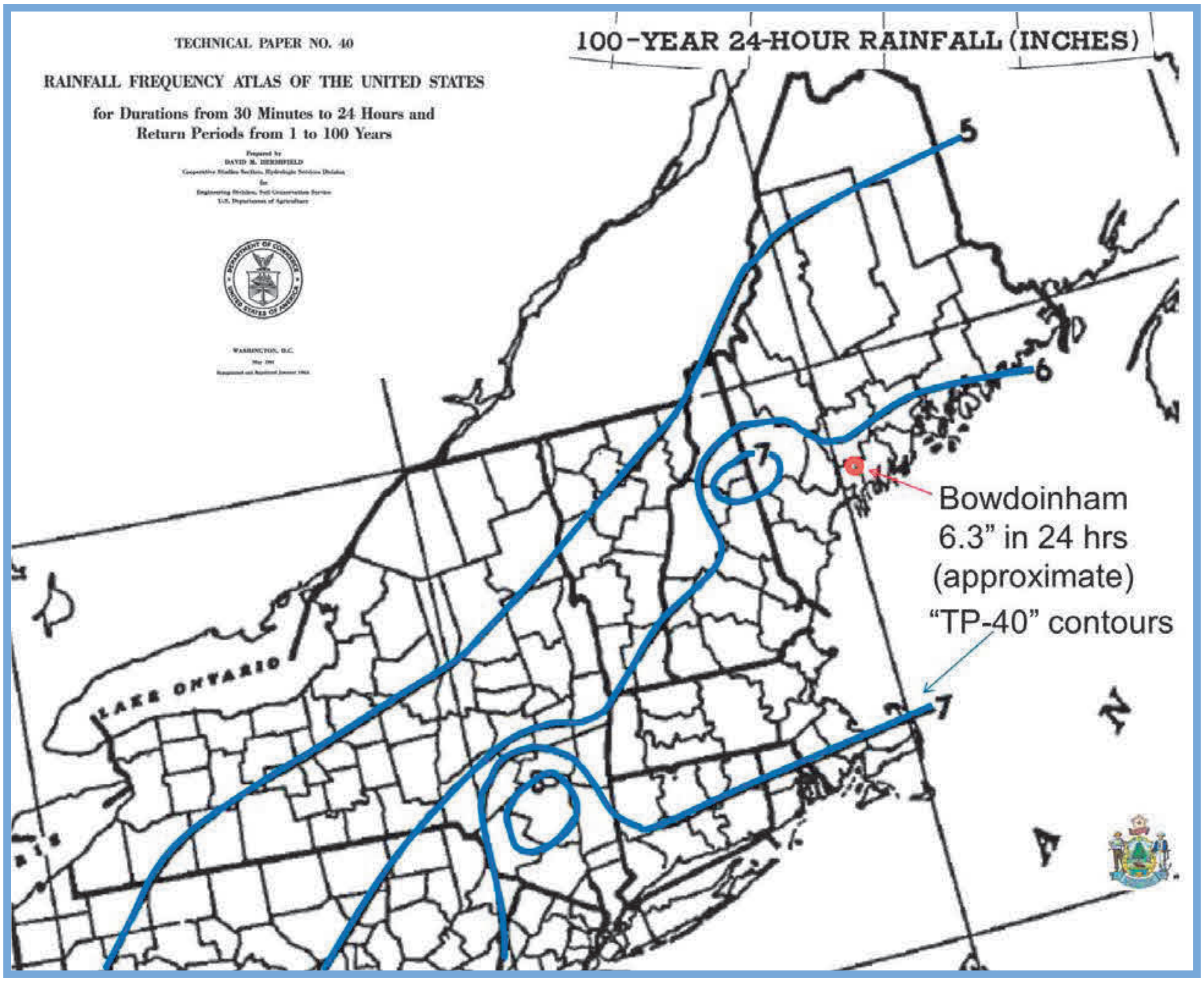
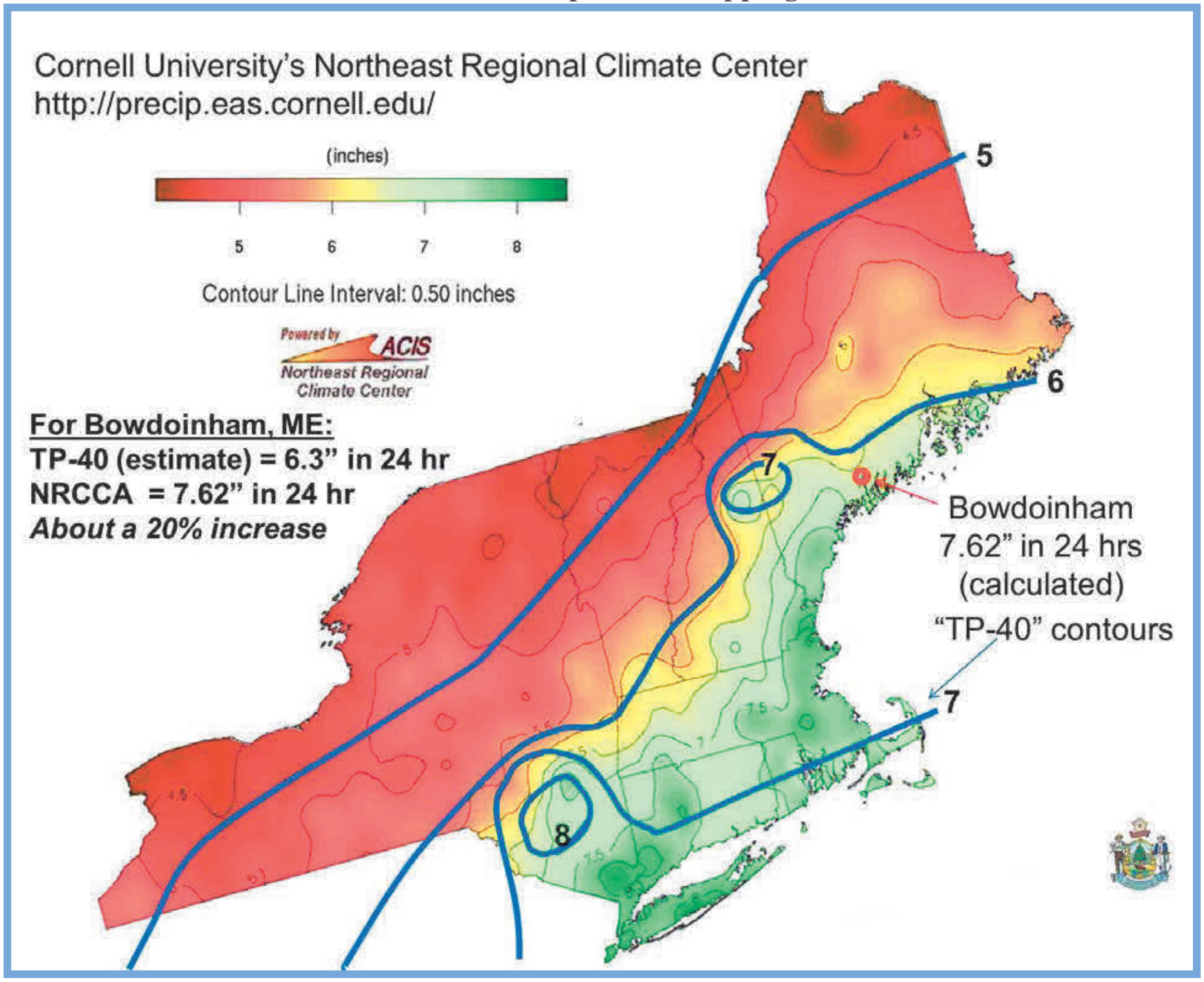


**Figure 14: New England Area, from Cornell University's Northeast Regional Climate Center Precipitation Mapping.**




*Other Climate Change Impacts Not Included in This Chapter*

It should be noted that other possible climate change impacts were not reviewed in the creation of this Comprehensive Plan chapter. These include such varied issues as:

- health impacts from insect-born diseases such as Lyme Disease;
- high heat days in summer;
- plant and animal species changes, as forest and ocean habitats change; and
- agricultural impacts with higher temperatures.

  Only issues of sea level rise and increased water levels on roads, rails, buildings, marshes, and land cover were considered in this chapter.