

SECTION 4. RISK ASSESSMENT

In compliance with Code of Federal Regulations, Part 201.6(c)(2), this section of the Plan identifies, profiles and assesses the vulnerability of Sagadahoc County to natural hazards. Our local risk assessments provide sufficient information to enable Sagadahoc County to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. This plan includes detailed descriptions of all the potential hazards that could affect Sagadahoc County, along with an analysis of Sagadahoc County's vulnerability to those identified hazards. Specific information about numbers and types of structures, potential dollar losses, and an overall description of land use trends are included in this analysis. Because this is a multi-jurisdictional plan, the risks that affect only certain regions of the County were assessed separately in the context of the affected region.

This section of the Plan contains eight subsections as follows (the numbering system begins with 5 to correspond to numbered sections of the Code of Federal Regulations):

5. Identifying Hazards (#5 below)
6. Profiling Hazards (#6 below)
7. Assessing Vulnerability: Identifying Assets (#7 below)
8. Assessing Vulnerability: Addressing repetitive loss properties (#8 below)
9. Assessing Vulnerability: Identifying Structures (#9 below)
10. Assessing Vulnerability: Estimating Potential Losses (#10 below)
11. Assessing Vulnerability: Analyzing Development Trends (#11 below)
12. Multi-jurisdictional Risk Assessment (#12 below)
13. Maps

No risk assessment of Sagadahoc County's natural hazards would be complete without first considering its climate and geography. Factors such as seasonal temperatures, annual precipitation, prevailing wind directions and topographical features can all profoundly affect both the occurrence and severity of hazards as diverse as floods and wildfires.

Sagadahoc County lies entirely within Maine's coastal division. Of the three climate zones within Maine, this climatic zone is most affected by the ocean, and because of the minimal elevation changes it is least affected by topography.

Temperature

Average high/low temperatures (F), based on data from the nearest National Weather Service station in neighboring Brunswick are:

<u>January:</u>	30.1 to 10
<u>April:</u>	52.4 to 34.2
<u>July:</u>	77.9 to 59.3
<u>October:</u>	58.4 to 39.4

Temperature extremes can range from 20 below zero to the high 90's. These temperatures tend to be moderated in the coastal communities.

Precipitation

Sagadahoc County averages approximately 48 inches of precipitation annually, based on records from nearby Brunswick. This includes the conversion of all snowfall to a water-equivalent. Distribution of this precipitation throughout the year is fairly uniform from month to month especially in the Coastal and Southern Interior Divisions. Statewide, average monthly precipitation is between three and four inches, with November being the wettest month, and February being the driest month. Coastal storms provide the abundant winter precipitation, especially in Sagadahoc County whereas the cool ocean water and sea breeze help to limit convective activity during the summer, thus inhibiting abundant thunderstorm activity that is responsible for so much of the summer precipitation in the interior parts of the county.

Prevailing Winds

As a mostly coastal county, Sagadahoc winds are often influenced by the wind patterns of the Gulf of Maine, which vary dramatically over the seasons. In summer, the gulf typically experiences weak winds from the southwest or southeast, which can bring warm, moist air resulting in fog formation. At times, coastal sections of the county may be in fog, while inland areas, such as Richmond, Bowdoin and Bowdoinham, are clear. Autumn winds tend to arise from the north- northwest. Winter and spring storms often are accompanied by strong winds. A familiar Gulf of Maine storm is the “nor’easter”, characterized by high winds that blow out of the northeast just ahead of the low pressure storm. Along with the rain or snow that “nor’easters” bring, high winds can produce strong waves that contribute to flooding and beach erosion.

5. Identifying Hazards	
Requirement §201.6(c)(2)(i): (The risk assessment shall include a) description of the type, location and extent of all natural hazards that can affect the jurisdiction.	
Element	A. Does the new or updated plan include a description of the types of all natural hazards that affect the jurisdiction?

A. Description of All Natural Hazards Potentially Affecting Sagadahoc County

The Sagadahoc County Hazard Mitigation Planning Team identified several natural hazards that are addressed in this Sagadahoc County Multi-jurisdictional Hazard Mitigation Plan. These hazards were identified through an extensive process that utilized input from members of the Hazard Mitigation Planning Team (comprised of representatives from state, county and municipal governments and educational, health and business representatives), public input, researching past disaster declarations in the County, and a review of current maps.

The following table identifies the natural hazards to be profiled as well as the hazards that were eliminated from further consideration in the plan, due to a lack of historical evidence, lack of overall county-wide severity or a low likelihood for the event to occur. However, although these disaster events were not profiled in the Hazard Mitigation Plan, it does not certify that any of these events will not or could not occur and cause great damage.

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Summary of All Natural Hazards Potentially Affecting Sagadahoc County		
Natural Hazard	Determination of Applicability to Sagadahoc County	Comment
Hazards Profiled in this Plan		
Flooding	Review of FEMA flood studies, flood maps, State data on disaster declarations, municipal official knowledge, and State Plan	There is a history of flooding in many parts of the County. The County contains numerous small streams and two major rivers.
Severe Winter Storms	Review of past disaster declarations, Committee and local knowledge, records from 1998 ice storm, State Plan, National Climate Data Center	Maine is frequently hit with blizzards and major “northeaster” storms. In 1998, a major ice storm hit Maine, knocking out power in many locations for days. Especially for Sagadahoc County, the impacts of winter storms include coastal erosion and wind damage.
Severe Summer Storms	Review of past disaster declarations, local knowledge, State Plan, and National Climate Data Center	Summer storms are often accompanied by high winds, road and culvert washouts and coastal erosion. On rare occasions, these storms may be accompanied by a microburst or small (unclassified) tornado, such as which occurred in late 2005.
Wildfire	Review of Maine Forest Service records, local knowledge and State Plan	Wildfires have been numerous and, with the exception of the 1947 fire, they have generally been small. Sagadahoc County faces access issues due to the many peninsulas, as well as a high reliance on volunteer fire departments.
Hazards Not Profiled in this Plan		
Avalanche	Review of USGS Maps, State Plan	There are no mountains in the County that hold large amounts of snow that would create avalanches.
Blight/Infestation	State Plan, local knowledge	There are no historical records of major blights or infestations with significant economic or public health impacts.
Coastal Erosion	See severe winter storms and severe summer storms	Included in profile for winter storms and summer storms.
Dam Failure	Review of Historical Records, State records	Included in profile for flooding.
Drought	State Plan	Severe, multi-year droughts occurred in Maine in the 1960’s and from 2000 to 2003. However, the effects of drought, such as wells running dry in some areas, have never been sufficient to create disaster conditions in Sagadahoc County, although they have increased the danger of wildfires.

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Summary of All Natural Hazards Potentially Affecting Sagadahoc County		
Natural Hazard	Determination of Applicability to Sagadahoc County	Comment
Earthquake	Maine Geological Survey, historical records, State Plan	Although Earthquakes are common in Maine, no significant motion has been shown for any fault since the last ice age about 20,000 years ago. The largest earthquake in Maine was recorded near Eastport (in Washington County) in 1904, but there are no records of any significant damage, and no indication that this area is threatened. All of the earthquakes that occur in Maine are intra-plate earthquakes. Maine is far inland from the boundaries of the North American plate which extends from the Mid-Atlantic ridge on the east to the western boundary of the U.S. Maine is near the middle of the plate and is therefore not subject to the frequent, deep and large earthquakes that are generated by the edges of the tectonic plates bumping into each other.
Hurricanes	Review of Historical Records, State records	Included in profile for severe summer storms.
Landslides	Review of Maine Geological Survey records, State Plan	Landslides are virtually unknown in Sagadahoc County. Sagadahoc County does not have any mountains or areas of steep terrain that could potentially be subject to landslides.
Subsidence	Review of Maine Geological Survey records, State Plan	There have been no known cases of significant land subsidence in Sagadahoc County.
Tornado, Severe Winds	Review NWS records, State Plan	On average, one to two tornadoes occur in the State of Maine each year, yet there has been no loss of life or major damage in many years (however, see profiles of winter and summer storms for high wind damages).

Climate Variation

The purpose of this part of the plan is not to debate climate change or its causes, but to provide an overview of how climate has changed over time, as documented in various scientific studies, and how that change may be impacting the occurrence and severity of natural hazards in Sagadahoc County. Projecting future climate change can be problematic because, as stated in the document “Maine’s Climate Future, 2015 Update,” by the University of Maine, “climate projections are uncertain for several reasons: natural climate variability, incomplete descriptions of the climate system in computer models, and difficulty in predicting future greenhouse gas emissions” (page 6).

Temperature Changes

Excerpts from the report “Maine’s Climate Future, 2015 Update,” prepared by the University of Maine, include the following:

“Average annual temperature across Maine warmed by about 3.0 degrees F between 1895 and 2014....Although the overall warming trend...is clear, Maine’s temperature signal also features significant year to year fluctuations superimposed on a distinct pattern with periods of relative cold...and warmth...” (page2).

“Numerical models of the global atmosphere and ocean have been in development for over

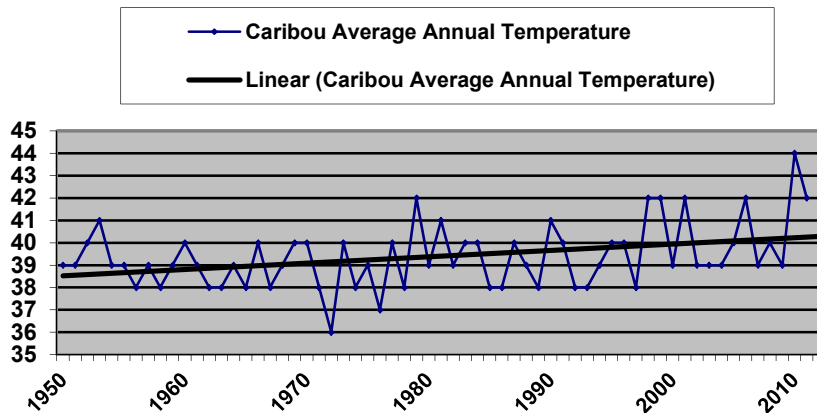
three decades. The most sophisticated of these models, such as those used by the Intergovernmental Panel on Climate Change (IPCC)...predict that annual temperature will increase another 3.0 – 5.0 degrees F...across Maine between now and 2050” (page 3).

“Maine’s warm season...increased by two weeks from the early 1900s to the 2000s. Global climate models predict that the warm season will increase by an additional two weeks over the next 50 years. Winter is warming at a faster rate than summer” (page 3).

The following is an excerpt from the Maine State Hazard Mitigation Plan 2013 Update:

“The National Weather Service in Gray, Maine, has compiled monthly average and annual average temperatures for a long period of time at three locations in Maine: The Portland International Jetport (1940-present); the Bangor International Airport (1953-1994 and 1999-present), and the Caribou Airport. The data from all three measuring stations show that annual average temperatures have gradually increased at all three locations...although the increase has been greatest at the Portland Jetport station” (page 3-4).

The chart below, taken from the State’s Hazard Mitigation Plan, page 3-5, shows how temperature has changed at the Caribou Airport between 1950 and 2010.



According to “Maine’s Climate Future, 2015 Update,” the impacts of rising temperature in Maine include an increase in Lyme disease resulting from more suitable habitat for deer ticks and their hosts, and stresses on Maine’s plant and animal species. The report does not indicate that temperature increases affect the severity of the hazards identified in this plan.

Precipitation Changes

Excerpts from the report “Maine’s Climate Future, 2015 Update,” include the following:

“Since 1895, total annual precipitation has increased by about six inches...or 13%, with most of the additional amount falling in summer and fall. IPCC models predict that precipitation will continue to increase across the Northeast by 5-10% between now and 2050, although the distribution is likely to vary across the climate zones. Model predictions show greater increases in precipitation in interior Maine...whereas measurements to date from the weather stations

across the Maine landscape show that precipitation has increased most along the coast” (page 8).

“A significant increase in extreme precipitation events (more frequent and intense storms) has been observed across Maine and other parts of the eastern U.S....we define an extreme precipitation event for this analysis as one in which two or more inches (five or more cm) of precipitation falls within a 24-hour period. Historical measurements show that extreme events vary across the state, occurring most often in the coastal zone and western mountains. The northernmost sites, like Millinocket and Caribou, show fewer extreme events overall, but with similar relative increases over the most recent decade” (page 9).

“In general, the snow season has declined on average across Maine since the late 1800s...on a simplified linear trend, the snowfall has declined by about 15%...although the amount and duration of snow may decline in the future, extreme snowfall events with significant accumulation – strong nor’easters – are likely to increase in frequency” (page 10).

“The Northeast has experienced a greater recent increase in extreme precipitation than any other region in the U.S.; between 1958 and 2010, the Northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events, taxing an already stressed and aging infrastructure” (page 11).

The following is an excerpt from the Maine State Hazard Mitigation Plan 2013 Update:

“The National Weather Service has also compiled monthly average and annual average precipitation at the Portland Jetport, the Bangor International Airport and the Caribou Municipal Airport. The data from all three measuring stations show that average annual precipitation ...has gradually increased at all three locations...The increase has been greatest at the Portland Jetport and the Caribou Municipal Airport” (page 3-5).

The chart below, taken from the State’s Hazard Mitigation Plan, page 3-6, shows how precipitation has changed at the Caribou Airport between 1950 and 2010.

The following table rates the natural hazards to be profiled:

Key to rating:

3	Severe	Multiple deaths, mass casualties, or millions of dollars in damages
2.5	High	Deaths or injuries; or \$100,000’s in damages
2	Moderate	Single death or injuries, or \$10,000’s in damages
1.5	Low	Injuries; or \$1,000’s in damages
1	Slight	No deaths, single injury, or \$100s in damages
A	Very likely	
B	Possible	
C	Very Unlikely	

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Rating of Hazards by Hazard Mitigation Planning Team			
Hazard	Damages	Rating	Priority
Flooding	Damages to structures, roads, bridges, culverts, utility infrastructure	3A	1
Severe Winter Storm	Downed power lines, blocked roadways and heavy snow damage to structures	3A	2
Severe Summer Storm	Localized flooding, high wind damage to utility lines, trees, roads and buildings	2.5A	3
Wildfires	Damage to timber, homes and businesses	2A	4

6. Profiling Hazards	
Requirement §201.6(c)(2)(i): (The risk assessment shall include a) description of the ...location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	
Elements	<p>A. Does the risk assessment identify the location (i.e., geographic area affected) of each natural hazard addressed in the new or updated plan?</p> <p>B. Does the risk assessment identify the extent (i.e., magnitude or severity) of each hazard addressed in the new or updated plan?</p> <p>C. Does the plan provide information on previous occurrences of each hazard addressed in the new or updated plan?</p> <p>D. Does the plan include the probability of future events (i.e., chance of occurrence) for each hazard addressed in the new or updated plan?</p>

FLOODING

General Definition

A temporary inundation of normally dry land as a result of: 1) the overflow of inland or tidal waters; and/or 2) the unusual and rapid accumulation or runoff of surface waters from any source. Note: the nature of Sagadahoc County's geology and hydrology is such that flooding is usually fast rising but of short duration.

Types of Flooding in Sagadahoc County

There are several different types of potential flooding in Sagadahoc County:

- Erosion/Coastal Erosion: As defined in FEMA's Coastal Construction Manual, this includes:
 - a.) beach erosion;
 - b.) bluff erosion; and
 - c.) coastal landslides.Under the National Flood Insurance Program, it's defined as the gradual wearing away of land masses. In general, erosion involves the detachment and movement of soil and rock fragments during a flood or storm or, over a period of years, through the action of wind, water, or other geological processes. Episodic erosion is induced by a single storm event.
- Dam Failure: The sudden release of water resulting from structural collapse or improper operation of the impounding structure. Dam failure can cause rapid downstream flooding, loss of life, damage to property, and the forced evacuation of people.
- Flash Flood: A flood event occurring with little or no warning where water levels rise rapidly due to heavy rains, ice jam release, or rapid snow melt.
- Ice Jam: An accumulation of floating ice fragments that blocks the normal flow of a river. During a thaw or rainstorm, the rapid increase in discharge from snow melt and/or rainfall can rapidly lift and break up a thick ice cover and carry it downstream as an ice run. Ice runs can jam in river bends or against the sheet ice covering flatter reaches. The resulting ice jams can block flow so thoroughly that serious flooding may result within an hour of their formation. Failure of an ice jam suddenly releases water downstream. Damages from ice jam flooding usually exceed those of clear water flooding because of higher than predicted flood elevations, rapid increase in water levels upstream and downstream, and physical damage caused by ice chunks. Moving ice masses can shear off trees and destroy buildings and bridges above the level of the flood waters.
- Riverine/Riparian: Periodic overbank flow of rivers and streams, usually the result of spring runoff, but can also be caused by major rain storms.
- Urban: Overflow of storm sewer systems, usually due to poor drainage, following heavy rain or rapid snowmelt. The combined sanitary and storm water systems that some urban areas installed years ago cause flooding of sanitary sewerage when riparian or coastal floods occur. Runoff is increased due to a large amount of impervious surfaces such as roof tops, sidewalks and paved streets.
- Beaver Dam Flooding: Flooding resulting from back-up and overflow of water resulting from beaver dams. In Sagadahoc County, flood damages from beaver dams have included washouts of roadways and other properties. For example, Phippsburg has identified at least one location vulnerable to this hazard.

A. Location of Flooding Hazard

The County EMA has reviewed the County's Flood Insurance Rate Maps (FIRMs) and Flood Insurance

Studies to compile a profile of the flooding hazard in the County. The Sagadahoc County Flood Maps were updated and the new version was effective in July 2015. Towns adopted the new maps, and updated flood management ordinances at their Town meeting in May and June of 2015. Flood zones are shown on some of the municipal base maps included in this Plan. Floods are described in local flood hazard studies in terms of their extent, including the horizontal area affected, and the related probability of occurrence. Flood studies use historical records to determine the probability of occurrence for different extents of flooding. The most widely adopted design and regulatory standards for floods in the United States is the 1 percent annual chance flood and this is the standard formally adopted by FEMA. The 1 percent annual flood, also known as the base flood, has a 1 percent chance of happening in any particular year. It is also referred to as the “100-year flood.”

Sagadahoc County’s susceptibility to flooding is further exacerbated by the wide-ranging weather variables as discussed in the climate section. Due to seasonal (and regional) factors such as heavy rains, rapidly melting snow pack and/or ice jams, major flooding most frequently occurs between December and May. Based on MEMA data, the most flood prone months are April, January and March, in order of severity. Floods can also be caused by hurricanes.

B. Extent (Severity) of the Hazard

Major riverine flooding (100-Event) is indicated by the following readings at the flood gauges on the Kennebec and Androscoggin Rivers as follows: North Sidney station at 11,000 cubic feet per second and at Auburn station at 17,000 cubic feet per second. Local flooding events occur when rainfall events over a 24 hour period begin to exceed over 3 inches. The highest 24 hour period rain event was 6.26 inches which occurred in the fall. Severe flooding can cause loss of life, property damage, disruption of communications, transportation, electric service and community services, crop and livestock damage, health issues from contaminated water supplies, molds and mildew within structural components, and loss and interruption of business.

The majority of the flood damage in the County is caused by winter runoff in the springtime, which undercuts or overtops local roads. When Sagadahoc County has above average snowfall for the winter, and then warmer temperatures and rainfall suddenly arrive in the spring, the snow pack melts off more quickly than the watersheds can handle. This causes local water bodies to overflow their boundaries and flood nearby road surfaces. Usually, the road damage is not major, but it can be significant, in which case it absorbs or exceeds a major portion of a municipal road budget.

Flood damages to roads, bridges and ditches continue to be a common occurrence throughout Sagadahoc County. Most washouts are quickly repaired, but often are not mitigated. As a result, replacement culverts, ditching and fill are just as susceptible to future flood damages as they were before the storm event.

Nature of Coastal Erosion Hazard

While flooding does cause erosion, wave action generated by winter storms, particularly northeasters, is the most threatening and of a short term emergency response type of natural hazard. In addition, chronic long-term erosion along many beaches is on the order of a foot per year, so there is a second form of erosion hazard that is more gradual but, nevertheless, a natural hazard that requires mitigation. The Patriot’s Day storm that occurred on April 16, 2007, was a northeaster that caused significant damage throughout Sagadahoc County.

The gradual rise in the level of the sea is having a profound effect on the nature of coastal flooding. The sea has risen about six inches since 1900, and is conservatively projected by the Maine Geological

Survey to rise by roughly two additional feet by 2100. Along the Sagadahoc County Coast, if the 10-year and 100-year storm elevations are only one foot apart, a sea level rise of one (1) foot means that a storm that had a 1% chance of occurring in any one year (the 100-year storm) at the original elevation will have a 10% chance of occurring in any one year (the 10-year storm) at the new elevation. As a result, more homes, businesses, public infrastructure such as roads, and entire communities will be subject to more devastating coastal storms, as well as coastal erosion and landslides, on a more frequent basis. There is also concern in the scientific community that global warming may be increasing the intensity of coastal storms.

A lack of detailed, accurate mapping of flood hazards along the coast has been an issue for many years. However, there have been several major mapping initiatives dating from the mid-2000s including the preparation of Hurricane Surge Inundation Maps by the US Army Corps of Engineers, and LIDAR mapping being undertaken the Maine Geological Survey for Sagadahoc County which were incorporated in the County's new Maps effective in July 2015.

Dam Failure Risk

Maine dams were constructed incrementally over a period of 300 years. Businesses harnessed the abundant fast flowing rivers and rocky rapids for the development of energy and transportation. Many dams throughout the country are now aged, and in Sagadahoc County the majority of these structures are nearly 100 years old and beyond the normal design life of civil engineering works. Many are low head dams constructed using local materials of stone, timber and earth. Some old dams have now been removed or lie in ruins. Unfortunately, some of the old (or unmonitored) sites have been built upon by beavers, impounding enough water to cause road washouts when they breach after heavy rains.

Maine law, consistent with federal law, classifies the hazard potential of dams as High, Significant or Low. If they fail, High Hazard dams could cause loss of life; Significant Hazard dams could cause significant property damage and Low Hazard dams would generally cause damage only to the owner's property. Therefore, it's possible that a small (low head) dam located above a large community could be rated High Hazard while a structurally larger dam sited in an unpopulated area could be a Low Hazard potential.

In Sagadahoc County, there are no High Hazard or significant hazard dams. In 2010, the Stoddard's Dam (MEMA ID #812) in Bowdoin was reclassified from Significant to Low Hazard because a vertical drop outlet pipe was installed to regulate the water (impoundment) level.

C. Previous Occurrences

The following table contains a summary of floods that have occurred in Sagadahoc County, as reflected primarily in Presidential Disaster Declarations. There have been no declarations for flooding in the county since 2010.

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Historical Summary of Major Flood Events in Sagadahoc County Since 1978			
Year	Month/Day	General Description	Presidential Disaster Declaration #
1978	Feb 8	High winds, tidal surge, coastal flooding	FEMA 550
1987	Apr 1	Major damage to homes, businesses, public buildings, sanitation facilities, erosion	FEMA 788
1991	Aug 28	Flooding, hurricane Bob	FEMA 915
2004	Dec 10-31	Severe storms, flooding, snow melt and ice jams	FEMA 1508
2007	Apr 15-23	Severe storms and inland and coastal flooding	FEMA 1693
2008	Dec 11-29	Severe winter storm and flooding	FEMA 1815
2010	Feb 23-Mar 2	Severe winter storms and flooding	FEMA 1891

Source: FEMA website and MEMA records

Patriot’s Day Storm, April 16, 2007

The Patriot’s Day Storm of 2007 was one of the most damaging storms to hit Sagadahoc County in recent years. According to the Gulf of Maine Ocean Observing System website, the Patriot’s Day Storm of 2007 will be long remembered for its meteorological significance and devastating power. Violent waves destroyed homes, businesses, coastal roads and beaches, while forceful winds tore down power lines, leaving many residents in the dark for days. Portland had a peak wind of 59 mph measured on April 16th. An abnormally high spring tide plus a storm surge of 3 feet (2.72 feet at the Portland tide gauge) produced a high tide of 13.28 feet (the 7th highest tide measured since the early 1900s).

The National Weather Service’s models had predicted a large snowstorm the week before that didn’t occur. Instead, the jet stream carried the storm’s energy over New England, dropping five to eight inches of rain along the coast, resulting in a significant coastal flooding event. During the Patriot’s Day storm, there were four high tide cycles in which the water was near or above flood stage and the waves were greater than 10 feet in height. This combination caused the tremendous amounts of damage seen during the storm (Gulf of Maine Ocean Observing System web site).

Flood Losses in Dollars by Municipality

The following table contains a summary of flood losses by Town for various Federal Disaster Declarations since 1987. The table includes only public assistance losses and does not include individual and business losses which can be substantial. Note that the storm of 2008 resulted in greater damages for Sagadahoc County as a whole, in large part because of very high damages in several towns (e.g. Bath and Topsham).

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Historical Summary of Recent Floods in Sagadahoc County				
Flood Disaster #, Year, and Public Works Damages				
Town	#915 1991	#1693 2007	#1815 2008	#1891 2010
Arrowsic	0	0	0	0
Bath	\$7,126	\$28,845	\$152,724	\$77,246
Bowdoin	12,282	34,492	20,997	0
Bowdoinham	3,449	11,889	36,381	0
Georgetown	3,721	60,223	2,012	24,620
Phippsburg	0	26,111	54,576	24,770
Richmond	5,199	8,105	52,739	0
Topsham	21,634	30,453	90,676	17,814
West Bath	1,729	22,533	9,705	5,916
Woolwich	17,560	42,035	7,993	24,725
Other*	2,157	4,262	0	8,545
Total	\$74,857	\$268,947	\$427,804	\$183,636

*Other may include damages to non-profits, county government, etc.

D. Probability of Occurrence

There are FEMA Flood Insurance Studies published for some Sagadahoc communities which provide some guidance on the probability of flood occurrence. However, it can be expected that on average a major flood event will cause mostly road damage in Sagadahoc County at least once every 5-10 years.

SEVERE WINTER STORMS

Sagadahoc County is subject to severe winter storm events including “Northeaster” winter storms that include very high winds. The entire county is subject to major snowfall events, but the northern half of the county typically will receive greater snowfall amounts. The entire County can experience a major ice storm, as it did in January 1998.

General Definition

Severe winter weather conditions that are characterized by low temperatures, strong winds, and often large quantities of snow.

Types of Winter Storms in Sagadahoc County

A single winter storm may include one or more of the following:

- **Blizzard:** Sustained winds of 40 mph (miles per hour) or more or gusting up to at least 50 mph with heavy falling or blowing snow, persisting for one hour or more, temperatures of ten degrees Fahrenheit or colder and potentially life-threatening travel conditions.
- **Ice Storms:** Rain which freezes upon contact. Ice coatings of at least one-fourth inch in thickness are heavy enough to damage trees, overhead wires, and similar objects and to produce widespread power outages.
- **Northeaster:** Northeasters (or nor'easters) are extra-tropical coastal storms that can produce

tremendous amount of precipitation and strong winds that can cause coastal flooding damage. When the precipitation is in the form of snow, sleet or freezing rain, it can damage overhead utility lines and become a highway driving hazard.

- Sleet Storm: Frozen rain drops (ice pellets) which bounce when hitting the ground or other objects, but in accumulated depths of two inches or more, produces hazardous driving conditions.
- Heavy snow storm: A snowfall of fifteen inches or more within 12 to 24 hours, which disrupts or slows transportation systems and the response time of public safety departments.

A. Location of Hazard

All ten municipalities in the County are subject to severe winter storms every winter.

B. Extent (Severity) of the Hazard

Severe winter snow falls can exceed 31.40 inches which can typically occur in January or February. Heavy snow fall in high wind conditions exceeding 40 miles per hour will create blizzard conditions. Likewise icing events begin to become a serious problem when it exceeds $\frac{1}{4}$ inch. Ice events exceeding one inch are common. Sagadahoc County is subject to severe winter storm events in the form of ice storms and blizzards, accompanied by high winds, wave action, coastal erosion and flooding. Winter storms can threaten Sagadahoc County at any time from November through April. The Gulf Stream follows a path up the eastern seaboard, bringing major storms with it to the Gulf of Maine. Air streams containing much colder air flow down from Canada and collide with the Gulf Stream over the New England region. Nor'easters, the most severe storm in Sagadahoc County, occur during the winter, spring and fall. They rarely develop during the summer.

Precipitation amounts can exceed several inches of water equivalent (20-30 inches of snow or more), while wind speeds can be equal to or greater than those for hurricanes that reach Maine. Loss of electrical power and communication services can impede the response of ambulance, fire, police and other emergency services, especially to remote or isolated residents. Roads can become impassable as the result of snow accumulation and drifting. Business closings can occur due to road conditions and loss of power. Structural failures are possible as the result of snow loads on roofs. This is of particular concern with respect to older structures built prior to the advent of snow-load design standards. Heavy snow loads can also result in the formulation of ice dams on roofs, leakage and damage to building interiors.

Total snowfall ranges from between 50 and 80 inches with variability correlating with distance from the immediate coast.

The snow pack makes an important contribution to both surface and groundwater supplies, and years with a low snow pack can lead to water shortages by late summer. Melting of the snow pack in March and April is often gradual enough to prevent serious flooding, but in Sagadahoc County, melting snow, combined with rainstorms, often overwhelms watersheds, ditches and culverts, which can lead to road washouts.

Along the coast, high winds associated with northeasters can also cause damage. The majority of coastal storms cause damage only to low coastal roads, boats, beaches, and seawalls. Occasionally, a major storm accompanied by strong onshore winds and high tides results in surge and wave activity that causes property damage and erosion.

The ice storm of January 1998 had a major impact on Sagadahoc County. Significant amounts of ice

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accumulated on utility lines, causing them to break. The costs of the ice storm were substantial. Utility crews from Maine and throughout the East Coast worked around the clock to clear downed trees and replace power lines.

On average, the length of annual maximum snow cover is four months or more throughout the county.

C. Previous Occurrences

The following table contains a summary some of the most severe winter storms that have occurred in Sagadahoc County, as reflected primarily in Presidential Disaster Declarations.

Historical summary of Major Winter Storm Events in Sagadahoc County Since 1972			
Year	Month	General Description	Presidential Declaration #
1972	Mar 7	Ice storm, severe storms, flooding	FEMA 326
1993	Mar 13 14	Blizzard	FEMA 3099-EM
1998	Jan 5-25	“Great Ice Storm of ‘98”; power outages, forestry damage	FEMA 1198-DR
2001	Mar 5-31	Severe winter storm	FEMA 3164-EM
2008	Dec 11	Severe winter storm and extreme cold	FEMA 3298-EM
\$	Feb 8-9	Severe winter storm	FEMA 4108-DR
2015	Jan 26-28	Blizzard	FEMA 4208-DR

The most severe winter storm was the ice storm of January, 1998, which caused over \$542,000 in damages throughout the County. This was far less than in counties farther inland, but it was still significant. Below freezing temperatures, combined with record rainfall, contributed to a blanket of solid ice throughout central Maine. Most State government offices were closed, and innumerable businesses were forced to close and remain closed because of blocked roadways and power outages.

The following table provides a town-by-town summary of damages resulting from the ice storm of 1998. The table includes only public assistance losses and does not include individual and business losses which can be substantial.

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Ice Storm of January, 1998 Town-by-Town Summary of Damages	
Arrowsic	0
Bath	\$83,270
Bowdoin	\$64,817
Bowdoinham	\$110,210
Georgetown	0
Phippsburg	\$21,409
Richmond	\$112,038
Topsham	\$99,617
West Bath	\$14,673
Woolwich	\$14,923
Other*	\$21,242
Total	\$542,199

*Other may include damages to private, non-profit, county government etc.

D. Probability of Occurrence

No probability studies have been done, but Sagadahoc County’s location in the Northeast, and its long experience with winter storms, indicate that between November and April of every year, there is a high probability that such storms will occur.

SEVERE SUMMER STORMS

Severe summer storm damages typically involve downed overhead utility lines, flooding from heavy rains, debris in the roads, and often erosion, particularly along the immediate coast.

General Definition

A violent weather phenomenon producing winds, heavy rains, lightning, and hail that can cause injuries and destruction of property, crops and livestock. Severe summer storms generally occur between June and early October.

Types of Summer Weather Events

There are several different types of summer weather events in Sagadahoc County:

- **Hurricane:** An intense, tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles per hour or more and blow in a large spiral around a relatively calm center called the “eye”.
- **Lightning:** An electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a “bolt”. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches a temperature approaching 50,000 degrees Fahrenheit in a split second. The rapid heating and cooling causes thunder.
- **Thunderstorm:** A storm formed from a combination of moisture, rapidly rising warm air and a force capable of lifting air such as a warm or cold front or sea breeze. All thunderstorms have lightning and can occur singly, in clusters or in lines.
- **Tornado:** A violently rotating column of air extending downward from a thunderstorm to the ground. The distinctive, slender, funnel shaped cloud, with wind velocities up to 300 miles per

- hour at the central core, destroys everything along its narrow ground path.
- **Microburst:** A small, extremely intense downdraft which descends to the ground creating strong wind divergence. Microbursts are typically limited to areas less than 2.5 miles across. This weather phenomenon is capable of producing damaging surface winds in excess of 100 mph. Generally, a microburst event will last no longer than 15 minutes.

A. Location of Hazard

The entire County is vulnerable to one or more severe summer storms each year, usually in the form of thunderstorms. The effects of summer storms are usually more common in the inland areas of the County and less noticeable along the coast where the cooling effects of the ocean tend to suppress thunderstorm activity.

B. Extent (Severity) of the Hazard

Sagadahoc County is subject to summer storms. During summer months, southwest to southerly winds become quite prevalent across the State. Because of the frequent formation of sea breezes, southerly winds are prevalent. When severe summer storms arrive in Sagadahoc County, high winds (40 mph) can fell trees and branches onto power lines, causing power and communication outages. Heavy rains (3 inches in 24 hour period) that often accompany thunderstorms can result in flash flooding or erosion. Lightning strikes can start fires. Any of these weather events can cause personal injury or property damage.

The impact of summer storms in Sagadahoc County is usually restricted to flooding and erosion caused by the large amounts of moisture these storms can carry. Summer storms can cause damage to low lying coastal roads, boats, beaches, seawalls and land area.

C. Previous Occurrences

The following table contains a summary of severe summer storms that have occurred in Sagadahoc County. Note: Flooding during the spring is often a result of snowmelt, which may be from winter storms. There have been no declarations for hurricanes or other severe summer storms in Sagadahoc County since 1991.

Historical Summary of Severe Summer Storm Events in Sagadahoc County			
Year	Incident Period	General Description	FEMA Disaster Declaration #
1954	Aug 25 - Sept 1	Hurricane Carol	None
1954	Sept 2 -15	Hurricane Edna	Presidential #24
1991	Aug 16 - 20	Hurricane Bob ¹	FEMA 915

¹ Tropical storm by the time it passed through Sagadahoc County. Source: FEMA/MEMA

The occurrence of tornadoes in the county has been very infrequent. There have been no F3 or greater tornadoes reported in Maine. According to data from the National Climate Data Center, from 1/1/1950 to 9/30/2010, Sagadahoc did not experience any tornadoes of any reportable strength. Some counties in Maine have experienced from one to several F2 tornadoes during this same 55-year time period. F2 tornadoes include winds of 113 to 157 miles per hour and are considered significant tornadoes. F2 tornadoes can tear roofs off frame houses, lift and move frame houses with weak foundations, demolish

mobile homes, and snap or uproot trees.

D. Probability of Occurrence

There have been no probability studies to indicate the frequency of summer storms. However, Sagadahoc County's location in the northeast, and its long experience with summer storms, indicate that each summer there is a high probability that summer storms will occur. In addition, impacts from hurricanes (the most severe storms) have occurred only three times during the past 60 years.

WILDFIRE

Sagadahoc County could be subject to wildfires. Nearly 80% of the County is forest land and the accessibility by vehicle to many areas is limited. A wildfire in October 1825 burned 3,000,000 acres in Maine and New Brunswick. The most severe wildfire in the State's recent history occurred in October of 1947. This fire burned 205,678 acres and caused 16 deaths. However, most of the damages were confined to Cumberland, Hancock, Oxford and York Counties.

All parts of the County could be subject to wildfires. However, the most northern portion of the county has the least accessibility to the productive forestland due to the lack of roads and development and the central and southern portion of the County has a larger number of homes and businesses within the Urban-Wildland Interface.

General Definition

A wildfire is a fire that burns vegetative cover such as grass, timber, or slash. Historically, wildfires have been primarily a natural phenomenon caused by lightning strikes, particularly during dry weather or drought conditions. However, in the recent past, humans have become the greatest cause of wildfire in Maine.

Types of Wildfires

There are two types of wildfires:

- Wildland fires: Burn vegetative cover or forest fuel.
- Wildland Urban Interface Fires: Created where homes meet with highly volatile forest fuels.

A. Location of Hazard

The Maine Department of Conservation, Forest Service, and Forest Protection Division tracks all reported fire occurrences in the State on an annual basis. These are coded by cause: campfire, children, debris burning – which can include backyard burning as well as the agricultural practice of "burning over" blueberry fields; incendiary (includes arson), lightning, machinery, miscellaneous, railroad and smoking. Most of these causes tend to correlate with population density. The number of fires by cause is shown on the next page, followed a town-by-town summary of fires.

B. Extent (Severity) of the Hazard

On average between 1 and 4 acres of land throughout the county is affected by wildfire. The most significant cause is machinery which could indicate vehicles or other farm/yard equipment. Based on historical records, Sagadahoc County could be subject to wildland fires and wildland urban interface fires because much of it is forested. Due to emergency access issues, the peninsulas might be the

most impacted.

Historically, forest fires were one of the State’s most significant hazards. Maine averages about 700 low acreage forest fires annually. Today, about 90% of all forest fires are caused by human activity, while 10% are caused by lightning. During dry periods, fire danger increases rapidly.

Well-distributed rainfall normally reduces forest fire risks, but seasonal variations, rapidly draining soils and unusually dry periods can induce major blazes. In addition, insect damage (such as the hemlock woolly adelgid and spruce budworm) diseases, severe weather, and residential and commercial developments in wooded areas greatly increase the potential for catastrophic fires. Over time, a considerable fuel supply can accumulate from dead trees left standing on the forest floor after insect infestations or from logging operations.

C. Previous Occurrences

Based on information obtained from the Maine Forest Service, there have been no major fires in Sagadahoc County in recent years. All of the wildfires known to have occurred were confined to relatively small land areas. The County has been hit with 49 wildfires from 2004 to 2009.

Fires in Sagadahoc County 2004 – 2009						
Town by Year & Number of Fires						
Town	2004	2005	2006	2007	2008	2009
Arrowsic	1	0	0	0	0	0
Bath	1	0	0	0	0	1
Bowdoin	3	0	1	1	0	0
Bowdoinham	2	0	2	0	2	2
Georgetown	0	0	0	1	0	0
Phippsburg	0	0	0	0	0	0
Richmond	3	1	5	1	4	2
Topsham	0	0	0	1	0	0
West Bath	0	1	2	0	2	0
Woolwich	0	2	2	1	4	1
Sagadahoc Co.	10	4	12	5	12	3

Fire in Sagadahoc County 2004 – 2009						
Total Acreage Burned						
Town	2004	2005	2006	2007	2008	2009
Arrowsic	0.9	0	0	0	0	0
Bath	2	0	0	0	0	1
Bowdoin	0.3	0	8.4	0.25	0	0
Bowdoinham	1.1	0	0.45	0	4.62	0.2
Georgetown	0	0	0	1	0	0
Phippsburg	0	0	0	0	0	0
Richmond	2.4	0.25	2.05	0.5	4.08	0.45
Topsham	0	0	0	0.3	0	0
West Bath	0	0.05	0.36	0	0.6	0
Woolwich	0	1.5	2.85	0.44	2.70	0.1
Sagadahoc Co.	6.7	1.8	14.1	2.49	12	1.75

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Sagadahoc County 2004 – 2009 Number of Fires by Cause						
Cause	2004	2005	2006	2007	2008	2009
Campfire	1	1	0	1	2	0
Children	3	1	3	0	0	0
Debris	2	2	4	0	3	2
Incendiary	0	0	1	1	1	0
Lighting	0	0	0	0	1	1
Machinery	1	0	1	1	2	2
Misc.	3	0	2	0	1	1
Smoking	0	0	1	2	2	0
Total	10	4	12	5	12	6

Sagadahoc County 2010 - 2015 Number of Fires and Acreage Burned by Cause								
Cause	Total Fire Events	2010 Acres Burned	2011 Acres Burned	2012 Acres Burned	2013 Acres Burned	2014 Acres Burned	2015 Acres Burned	Total Acres by Cause
Camp	5	1.1	0.25	0.1	0	0.5	0	1.95
Campfire	1	0	0	0	0	0	0.2	0.2
Children	3	0	0	0.8	1	0	0	1.8
Debris	5	0.7	0	0.1	0.15	0	0	0.95
Debris Burn	1	0	0	0	0	0	1	1
Equipment Use	2	0	0	0	0	0	0.35	0.35
Incendiary	4	0.3	0	0.35	0	0	0	0.65
Lighting	1	0	0	0.25	0	0	0	0.25
Machinery	15	0.5	1.1	2.14	0	0	0	3.74
Miscellaneous	7	0	0	0	0	0.17	2.45	2.62
Smoking	2	0.25	0	0	1	0	0	1.25
Totals	46	2.85	1.35	3.74	2.15	0.67	4	14.76

D. Probability of Occurrence

While probability studies have not been done, based on historical records of fires, the Maine Department of Conservation, Maine Forest Service, Forest Protection Division, anticipates that there will be between 600 and 700 low acreage fires (from all causes) in Maine each year. However, using the last three years of fire records, the probability of a major wildfire is once a decade. Sagadahoc County faces access issues due to the many peninsulas, as well as a high reliance on volunteer fire departments.

7. Assessing Vulnerability: Overview	
Requirement §201.6(c)(2)(ii): (The risk assessment shall include a) description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.	
Elements	A. Does the new or updated plan include an overall summary description of the jurisdiction's vulnerability to each hazard?

	B. Does the new or updated plan address the impact of each hazard on the jurisdiction?
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A. Vulnerability of Sagadahoc County to each Hazard

Flooding

Some of the County’s most serious flooding is caused by winter runoff in the springtime when water undercuts or overtops local roads. Coastal beach erosion is also an issue in several locations. Most of the developed areas in Sagadahoc County are located outside of designated flood plains, and are thus not very vulnerable to flooding. On the other hand, many parts of the County are very rural in nature, and are served by a network of rural roads that do not have proper storm drainage systems. These roads are very vulnerable to flooding caused by heavy downpours and/or the blockage of drainage systems by ice or debris, even though these roads may not be in an identified flood plain. See also discussion of dam breach flooding on page 4-7.

Severe Winter Storms

Sagadahoc County’s location in Northern New England places it in a high-risk area for winter storms. While the majority of winter storms in Sagadahoc County occur during the winter season of December through March, there are occasional winter storms in the late fall (November and early December) and in the spring (March through April). However, the severity of storms is typically most serious in January and February, with storms in the earlier and later parts of the seasons usually being of lesser magnitudes.

The time of day at which storms occur is also important, as overnight storms allow for the closure of schools and businesses, whereas storms during the day force people to travel home during storm conditions. Based on past experience, storms are most likely to occur overnight or during the morning, but afternoon storms are still somewhat likely.

A major ice storm of the severity that occurred in 1998 would impact nearly all of Sagadahoc County and threaten the overhead electric and telephone lines. Roads may be closed due to washouts and debris in roads from trees and utility lines.

As noted earlier in this Assessment, Sagadahoc County has been included in several Presidential Disaster Declarations for winter storms. Sagadahoc County contains at-risk populations that could be impacted by a major winter storm. Sagadahoc County maintains a list of people who are at risk, and contacts them by phone during winter storms to see if they need any assistance.

Severe Summer Storms

The entire County is vulnerable to thunderstorms, microbursts and high winds, especially from the very high winds that often accompany severe coastal summer storms. Heavy rains that often accompany such storms can erode vulnerable shoreland areas.

Wildfires

Sagadahoc County is heavily forested, and is vulnerable to wildfires. However, all of the organized municipalities in Sagadahoc County are served by capable fire departments. The Maine Forest Service has been very active in forest fire prevention activities, and, through meetings convened by the Sagadahoc County Emergency Management Agency, meets periodically with municipal fire chiefs on

matters related to wildfire prevention and response activities. It is important to note that a wildfire event much like any other hazard event which occurs on a peninsula poses a particular vulnerability due having only a single road out of the peninsula.

B. Impacts of Each Hazard on Sagadahoc County

Flooding

Damages resulting from flooding in Sagadahoc County include damages to roads and their respective drainage systems. Historically, flood damages have included partial or complete road washouts, as well as severe erosion of roadside ditches, resulting in hazards to motorists if their vehicles go off the road. See also discussion of dam breach flooding on page 4-7.

Severe Winter Storms

The impacts of severe winter storms include road closures (and the subsequent inability of emergency vehicles to provide help), the loss of power for extended periods of time, high costs to local governments for snow removal/ice treatment efforts, and loss of income to businesses and individuals due to business closures.

Severe Summer Storms

The damages from severe summer storms typically involve the washout of roads, downed utility lines and debris clearance. If severe enough, this can result in the loss of income to businesses and individuals due to business closures.

Wildfires

The primary impacts include damages to homes located in the wildland-urban interface and loss of valuable timberland. A larger percentage of homes in rural towns are located in the wildland-urban interface than homes in village areas.

8. Assessing Vulnerability: Addressing Repetitive Loss Properties	
Requirement §201.6(c)(2)(ii): (The risk assessment) must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged (by) floods.	
Element	A. Does the new or updated plan describe vulnerability in terms of the types and numbers of repetitive loss properties located in the identified hazard areas?

Based on information obtained from the Maine Floodplain Office, there are three repetitive loss properties in Sagadahoc County, as shown in the table below. In accordance with the Federal Privacy Act, the Maine Floodplain Office will not disclose the addresses, owner names or claim information of these repetitive loss properties.

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Sagadahoc County Repetitive Loss Properties				
Town/City	Residential Structures		Non-Residential Structures	
	# Properties	# Losses	# Properties	# Losses
Bath	0	0	1	4
Bowdoinham	0	0	1	2
Phippsburg	1	3	0	0

Source: NFIP Program

Summary of Flood Insurance Policies in Sagadahoc County							
Town/City	Total Premium	V Zone	A Zone	# Policies	Total Coverage	Total Claims Since 1978	Total Paid Since 1978
Arrowsic	\$2,190	0	1	2	\$482,400	0	0
Bath	\$50,217	0	15	42	\$9,734,400	13	\$376,399
Bowdoin	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bowdoinham	\$6,638	0	4	8	\$1,480,200	5	\$68,373
Georgetown	\$41,828	5	5	34	\$8,782,900	8	\$7,262
Phippsburg	\$56,255	1	31	61	\$13,733,500	32	\$166,454
Richmond	\$5,534	0	4	7	\$970,500	6	\$24,521
Topsham	\$14,504	0	10	25	\$6,223,000	6	\$19,494
West Bath	\$8,568	0	5	9	\$1,821,300	2	\$14,893
Woolwich	\$1,702	0	0	4	\$1,400,000	2	\$5,621
Totals:	\$187,436	6	75	192	\$44,628,200	74	\$683,017

9. Assessing Vulnerability: Identifying Structures	
Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	
Elements	<p>A. Does the new or updated plan describe vulnerability in terms of the types and numbers of existing buildings, infrastructure, and critical facilities located in the identified hazard areas?</p> <p>B. Does the new or updated plan describe vulnerability in terms of the types and numbers of future buildings, infrastructure, and critical facilities located in the identified hazard areas?</p>

This section of the Plan identifies existing buildings, infrastructure and critical facilities within the County and the hazards to which these facilities are susceptible. A critical facility is defined as a facility in either the public or private sector that provides essential products and services to the general public, is otherwise necessary to preserve the welfare and quality of life in the County or fulfills important public safety, emergency response, and/or disaster recovery functions.

The Sagadahoc County Hazard Mitigation Planning Team used GIS map data, information contained in local comprehensive plans, State databases, and local knowledge to locate the County's critical facilities and determine which are most likely to be affected by hazards. The four hazards most likely to impact the County are flooding, winter storms, summer storms and wildfires. The analysis revealed the following:

A. Vulnerability of Existing Buildings, Infrastructure and Critical Facilities Flooding

Facilities Flooding

- **Buildings:** Flooding of buildings has occurred in the City of Bath and in the Town of Phippsburg, particularly in the Popham Beach area. However, most of the developed areas of Sagadahoc County are located outside designated flood plains.
- **Infrastructure:** The typical damage resulting from flooding in Sagadahoc County is structural damage to roads and utility infrastructure. There may be other types of infrastructure that are susceptible to damage from flooding, but insufficient data was available to determine these facilities.
- **Critical Facilities:** Due to the varied topography within the County and the availability of higher elevation sites within all municipalities, nearly all critical facility structures are located outside of the flood zones.

Severe Winter Storms

- **Buildings:** All buildings in Sagadahoc County are vulnerable to winter storms. Damages can include burst water pipes during power outages, interior water damages due to ice dams forming on roofs, and occasionally, roof collapses due to heavy snow loads.
- **Infrastructure:** A "Northeaster", blizzard, ice storm or severe coastal storm of the severity that occurs once every 3-5 years, and/or a winter storm with severe winds, would have a negative impact on all roads in the County and on all overhead electrical power and telephone lines. Roads may be covered in snow, washed out or blocked with tree debris. Utility lines and poles will be felled. A coastal storm could cause general erosion to local roads and beach areas and wind damage to coastal buildings, as well as flooding of some roads.
- **Critical Facilities:** No critical facilities were identified as being in danger from a severe winter storm.

Severe Summer Storms

- **Buildings:** Localized events, such as microbursts or small tornadoes, have the potential to cause significant damage to structures. Damages can result from debris like tree limbs, and from high winds and interior water damages due to wind-driven rain. Infrastructure. The more widespread events, such as hurricanes and tropical storms will typically impact the county through severe damage to overhead electric and utility line infrastructure and blockage of roads by debris. When accompanied by flooding, the impacts will be as described above. A summer storm could cause erosion to local roads and beach areas.
- **Critical Facilities:** All critical facilities in Sagadahoc County are vulnerable to summer storms in the same manner that individual buildings are vulnerable. However, some of the critical facilities throughout the County have back-up generator systems, which allow building systems to continue operating during a power outage. The municipal base maps that are included in this Plan update identify the location of critical facilities.

Wildfires

- Buildings: Wildfires could have a large impact on homes located in the wildland/urban interface, as well as some commercial structures.
- Infrastructure: Wildfires would likely have a lesser impact on overhead electrical and telephone transmission lines. Roads and their storm drainage systems are much less vulnerable, although road access to certain areas could be blocked by fires and by emergency fire-fighting vehicles.

- Critical Facilities: Wildfires in Sagadahoc County have tended to be relatively small, and have not been a threat to critical facilities. In the event of a very large wildfire, some critical facilities could be damaged by fire and smoke.

Critical Facilities. The critical facilities identified in Sagadahoc County are:

- Municipal offices
- Fire and police stations
- Post offices
- Town garages and salt/sand sheds
- Hospitals and clinics
- Schools that have been identified as shelters
- Electrical, communication and pipeline utilities
- Water and wastewater treatment facilities
- Hazardous material sites
- Airports
- Dams
- Bridges
- Rail Systems

County Asset Inventory

The following chart identifies the type and number of critical facilities in each town in Sagadahoc County. (Chart updated in 2016)

County Asset Inventory by Municipality												
Town/City	Town Office	Fire/Rescue	Police	Public Works, Salt/Sand	School	Hospital/Health	Sewage Treatment	Water Supply	Dams	Bridges	Hazardous Facilities	Other
Arrowsic	1	2	0	0	0	0	0	0	0	0	0	0
Bath	1	2	1	3	7	1	1	1	2	2	0	0
Bowdoin	1	1	0	1	1	0	0	0	1	1	0	0
Bowdoinham	1	1	0	1	1	1	0	0	1	0	1	0
Georgetown	1	2	0	3	1	1	0	0	0	0	0	0
Perkins Township	0	0	0	0	0	0	0	0	0	0	0	0
Phippsburg	1	2	0	2	1	0	0	0	0	2	0	0
Richmond	1	1	1	3	2	1	1	1	0	0	0	0
Topsham	1	1	1	2	3	1	0	0	5	4	0	1
West Bath	1	1	0	1	1	0	1	0	0	1	0	1
Woolwich	1	2	0	3	1	0	0	0	0	3	0	0
Totals	10	15	3	19	18	5	3	2	9	13	1	2

In addition to critical facilities, Sagadahoc County contains at-risk populations that should be factored into the vulnerability assessment. These include a relatively large population of elderly residents who live alone in very rural areas and who have limited mobility.

B. Vulnerability of Future Buildings, Infrastructure and Critical Facilities

As documented more fully in Section 6, there are a number of local ordinances that will significantly reduce the vulnerability of future buildings, infrastructure and critical facilities to the hazards profiled in this Plan. All of the municipalities have a comprehensive plan, all are members of the National Flood Insurance Program and have a floodplain management ordinance, all have shoreland zoning ordinances, and subdivision regulations. Beginning in December of 2010, a new, statewide building code went into effect. It is too early to predict whether or not this will have an impact on the vulnerability of future buildings and critical facilities, but it will regulate methods of construction.

The Maine Office of Community Development has projected that Sagadahoc County's population will decrease, in part because of the closure of the Brunswick Naval Air Station. The County is expected to decline from about 36,332 people in 2008, to about 34,964 people by 2018 (a loss of about 1,368 people, or 3.8 %). Given the projected decline, there will be very few if any future buildings,

infrastructure or critical facilities that will be vulnerable to the identified hazards.

Flooding

- **Buildings**: The majority of damages from flooding are to roads, not structures. All of the municipalities in Sagadahoc County have floodplain ordinances that provide control over development in flood prone areas, and these ordinances would also regulate the location of future buildings.
- **Infrastructure**: Future roads and their associated storm drainage systems would seem to be the most likely category of infrastructure that would be vulnerable to flooding. However, State and local road construction standards generally ensure that new roads are properly constructed with adequate storm drainage systems. Most if not all roads in the public domain must be designed by a registered professional engineer. Therefore, flooding of future roads is not likely to be a serious issue in Sagadahoc County.
- **Critical Facilities**: Because of the requirements of the Flood Insurance Program, as well as shoreland zoning requirements and a greater awareness of flooding in all communities, future critical facilities will continue to be located outside floodplain areas. The exception may be wastewater treatment plants, due to the need to locate these facilities at lower elevations.

Severe Winter Storms

- **Buildings**: Improvements in building construction due to the State's new building code will help protect future buildings against damage from heavy snow loads and ice buildup. Damages may include burst water pipes, but many newer buildings will be better insulated than older ones, thus being better able to retain heat during longer periods of time when there is a power outage. There will be less interior water damage due to ice dams forming on roofs because the roofs of newer buildings generally are properly vented, which allows the roofs to remain cold. Roof collapses due to heavy snow loads will be very rare because newer roofs are designed to withstand heavy snow loads.
- **Infrastructure**: Roads will continue to be the most vulnerable category of infrastructure. New roads can be just as easily blocked on a temporary basis due to heavy snowfall, ice building up on the road surface, and debris such as tree limbs accumulating on the road surface during a storm event. However, in the present economy, it is unlikely that Sagadahoc County will experience much new road construction, with the possible exception of small road segments serving subdivisions.
- **Critical facilities**: Future critical facilities in Sagadahoc County will be vulnerable to winter storms in the same manner that individual buildings will be vulnerable. However, some of them will have back-up generator systems which will allow heating systems to continue operating during a power outage.

Severe Summer Storms:

- **Buildings**: It is unlikely that severe summer storm will have any impact on future structures, with the possible exception of a hurricane which is a once-per-decade event in Sagadahoc County. Most of the damages from summer storms are erosion-related, resulting in damages to roads. New buildings in Sagadahoc County will be less vulnerable to severe summer storms because they are built to meet modern code requirements. State- mandated shoreland zoning ordinance regulations for areas within 250 feet of the shoreline of the coast, lakes and ponds, and within 75 feet of streams, limit the location of new buildings in areas prone to coastal erosion and storm surges that often result from Severe Summer Storm Events. Damages may include roof damage from falling trees and debris. There will be less Interior water damage due to wind-

driven heavy rains because the roofs of newer buildings generally are properly designed and roofing materials are more resistant to water infiltration.

- **Infrastructure:** Roads will continue to be the most vulnerable category of infrastructure. New roads can be blocked on a temporary basis due to heavy rainfall, and debris such as tree limbs accumulating on the road surface during a storm event.
- **Critical Facilities:** Future critical facilities in Sagadahoc County will be vulnerable to summer storms in the same manner that individual buildings will be vulnerable. However, some of them will have back-up generator systems which will allow building systems to continue operating during a power outage. The municipal base maps that are included in this Plan update identify the location of critical facilities.

Wildfires

- **Buildings:** Forest fires in Sagadahoc County primarily threaten residential structures in the wildland/urban interface. In most Sagadahoc County communities, homes are allowed to be constructed in most locations in the community.
- **Infrastructure:** Future power, phone and cable lines can be damaged during a wildfire, although the level of future development is expected to be minimal, primarily because of the projected population decline for the County.
- **Critical Facilities:** Future critical facilities may be vulnerable to a very large wildfire. However, the expectation is that there will be very few new critical facilities constructed during the life of this plan.

10. Assessing Vulnerability: Estimating Potential Losses	
Requirement §201.6(c)(2)(ii)(B): (The plan should describe vulnerability in terms of an) estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate.	
Elements	A. Does the new or updated plan estimate potential dollar losses to vulnerable structures?
	B. Does the new or updated plan describe the methodology used to prepare the estimate?

Overview

This section of the Plan relies on historical damages as the basis for estimating future losses, subject to the following:

- Historical damage estimates have been updated, using the Consumer Price Index shown below;
- Presidential Disaster Declarations have been used where possible, updated for inflation using the Consumer Price Index below;
- Where statewide or county damages are used to determine damages for a specific jurisdiction, the damages are pro-rated using the 2010 Census.

The average annual Consumer Price Index for various years is shown below based on a value of 100 for the years 1982-1984.

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Consumer Price Index, 1982-1984 = 100					
Year	Price Index	Year	Price Index	Year	Price Index
1947	22.3	1991	136.2	2004	188.9
1954	26.9	1992	143.3	2005	195.3
1980	82.4	1993	144.5	2006	201.6
1981	90.9	1994	148.2	2007	207.3
1982	96.5	1995	152.4	2008	215.3
1983	99.6	1996	156.9	2009	214.5
1984	103.9	1997	160.5	2010	218.1
1985	107.6	1998	163.0	2011	224.9
1986	109.6	1999	166.6	2012	229.6
1987	113.6	2000	172.2	2013	232.9
1988	118.3	2001	177.1	2014	236.7
1989	124.0	2002	179.9	2015	236.8
1990	130.7	2003	184.0		

Flooding: This plan uses worst-case, real-life damages to calculate potential flood losses, and assumes that historic patterns will hold for the future. The worst case flood is the Patriot’s Day storm of 2007, which resulted in a Presidential Disaster Declaration of about \$22 million in damages to 13 counties. Using the Consumer Price Index (CPI), the damages in 2015 dollars would be about \$25,120,115 (multiply \$22,000,000 by 236.7 – the CPI for 2015, and divide by 207.3 – the CPI for 2007). Damages in Sagadahoc County from the Patriot’s Day storm amounted to \$268,947,000 which would be \$307,090,000 in 2015 dollars.

The methodology for calculating potential losses in Sagadahoc County is to assume the greater of:

- 1) Actual damages from the Patriot’s Day storm updated using the Consumer Price Index (column A in the table on the next page),
- 2) Actual damages from flooding in 2008, updated using the Consumer Price Index, (column B; the 2008 storm resulted in much greater damages to five Sagadahoc County towns than the Patriot’s Day storm),
- 3) Flood losses based on \$23 per capita (column C). The \$23 is calculated by taking the population of the counties that suffered damages in the Patriot’s Day Storm (1,085,033 – the population of the State exclusive of Aroostook, Penobscot and Piscataquis Counties which were not included in the declaration) and dividing it into total Patriot’s Day storm damages in 2015 dollars to get a per capita cost of \$23. Each town’s population is multiplied by \$23 to get potential damages.

The maximum flood loss (column D) is the greater of columns A, B or C. In most cases, column C results in the highest loss estimate.

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Potential Flood Losses in Sagadahoc County				
Town/City	A. Updated 2007 Flood Losses Using 2015 CPI	B. Updated 2008 Flood Losses Using 2015 CPI	C. Flood Losses Based on \$23/Capita	D. Maximum Potential Flood Loss
Arrowsic	0	0	\$10,235	\$10,235
Bath	\$32,936	\$167,904	\$191,452	\$191,452
Bowdoin	\$39,384	\$23,084	\$70,518	\$70,518
Bowdoinham	\$13,575	\$39,997	\$66,240	\$66,240
Georgetown	\$68,764	\$2,212	\$22,954	\$68,764
Phippsburg	\$29,814	\$60,000	\$49,519	\$60,000
Richmond	\$9,254	\$57,981	\$78,039	\$78,039
Topsham	\$34,772	\$99,689	\$201,250	\$201,250
West Bath	\$25,729	\$10,669	\$45,494	\$45,494
Woolwich	\$47,996	\$8,787	\$70,495	\$70,495
Other*	\$4,866	0	0	\$4,866
Total	\$307,090	\$470,323	\$633,886	\$867,353

*Other may include losses to private, non-profit, county government etc.

Winter Storms: This plan uses worst-case, real-life damages to calculate potential winter storm damages, and assumes that historic patterns will hold for the future. For Sagadahoc County, the worst storm is the ice storm of 1998, which resulted in a statewide Presidential Disaster Declaration of \$47,748,466. The actual damages were closer to \$100,000,000 because the Disaster Declaration did not cover damages to power lines and private structures. Using the Consumer Price Index, the \$47.7 million in damages would be \$69.4 million in 2015 dollars (multiply \$47.7 million by 236.7 – the CPI for 2015 and divide by 163.0 – the CPI for 1998). The 1998 damages in Sagadahoc County totaled \$542,199 (far less than some interior counties), which would be \$787,352 in 2015 dollars.

The methodology for calculating potential losses in Sagadahoc County is to assume the greater of:

- 1) Actual damages updated using the Consumer Price Index (column B in the table below), or
- 2) Winter storm losses based on \$48 per capita (column C in the table below). The \$48 is calculated by taking the 2010 population of the State (1,328,361) and dividing it into total 1998 ice storm damages in 2010 dollars (\$63,800,000) to get a per capita cost of \$48. Each town's population is multiplied by \$48 to get potential damages.

The maximum winter storm loss (column D) is the greater of column B or C. In most cases, column C results in greater potential damages.

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Potential Winter Storm Losses in Sagadahoc County				
Town/City	A. Actual 1998 Ice Storm Damages	B. Updated Ice Storm Losses Using 2015 CPI	C. Winter Storm Losses Based on \$48 Per Capita	D. Maximum Potential Winter Storm Loss
Arrowsic	0	0	\$21,360	\$21,360
Bath	\$83,270	\$120,920	\$399,552	\$399,552
Bowdoin	64,817	\$94,124	\$147,168	\$147,168
Bowdoinham	110,210	\$160,041	\$138,240	\$160,041
Georgetown	0	0	\$47,904	\$47,094
Phippsburg	21,409	\$31,089	\$103,344	\$103,344
Richmond	112,038	\$162,695	\$162,864	\$162,864
Topsham	99,617	\$144,658	\$420,000	\$420,000
West Bath	14,673	\$21,307	\$94,944	\$94,944
Woolwich	14,923	\$21,670	\$147,120	\$147,120
Other*	21,242	\$30,846	0	\$30,846
Total	542,199	\$787,462	\$1,682,496	\$1,735,143

*Other may include losses to private, non-profit, county government etc.

Severe Summer Storms: Hurricane damages are included in the Severe Summer Storm Events category profiled in this Plan, and not as a separate category due to the low occurrence of hurricanes in Sagadahoc County, as noted earlier in this Plan. Worst case, real life damages were used to calculate potential damages from hurricanes. The most recent, devastating hurricane to hit Sagadahoc County was Hurricane Carol in 1954.

Carol produced \$5,000,000 in damages to a swath of coastal Maine that included the following counties: Sagadahoc, Cumberland, Knox, Lincoln, Waldo and York. The population of these six counties totaled 351,465 people (1950 Census), resulting in a per capita damage of \$14/person. In 2015 dollars, this would be \$123.2/person (multiply \$14 by the CPI of 236.7 and divide by the 1954 CPI of 26.9). There has been a substantial amount of primary and secondary home and commercial development in these six counties since 1954, and the population of these six counties increased to 627,077 people by the year 2010 (U.S. Census). The per capita damages should therefore be increased to \$220 (multiply 123.2 by 627,077 – the six-county population for 2010, and divide by 351,465 – the six-county population for 1954).

The following table includes a town-by-town estimate of potential hurricane damages based on the 2013 Census and a per capita damages figure of \$220.

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Potential Hurricane Damages in Sagadahoc County		
Town/City	Year-Round Population 2013	Potential Hurricane Damages (Population x \$220)
Arrowsic	445	\$97,900
Bath	8,324	\$1,831,280
Bowdoin	3,066	\$674,520
Bowdoinham	2,880	\$633,600
Georgetown	998	\$219,560
Phippsburg	2,153	\$473,660
Richmond	3,393	\$746,460
Topsham	8,750	\$1,925,000
West Bath	1,978	\$435,160
Woolwich	3,065	\$674,300
Total	35,194	\$7,742,680

Wildfires: This plan uses worst-case, real-life damages to calculate potential wildfire losses, and assumes that historic patterns will hold for the future. The 1947 fire was the worst on record, although it was actually a series of wildfires that flared over Eastern and Southern Maine. The 1947 fire caused an estimated \$30,000,000 in damages to Cumberland, Hancock, Oxford and York Counties. The damage in 2015 dollars would be about \$318,430,493 (multiply \$30 million by 236.7– the CPI for 2015, and divide by 22.3 – the CPI for 1947). While there is significantly more development in each of these counties today than there was in 1947, fire-fighting capabilities have also increased substantially since that time so there may be no need to further increase the damage estimate. The probability that a wildfire such as the 1947 fire will hit Sagadahoc County during the five-year period covered by this Plan is low.

The methodology for calculating potential wildfire losses in Sagadahoc County is based on the damages that occurred in the 1947 fire in Cumberland, Hancock, Oxford and York Counties. The population of these counties is 591,056. Divide \$318,430,493 (the 1947 fire in 2015dollars) by 591,056 to get a per capita cost of \$539. Multiply each town’s population by \$539 to get potential wildfire damages.

Potential Wildfire Damages in Sagadahoc County		
Town/City	Year-Round Population 2013	Potential Wildfire Damages (Population x \$539)
Arrowsic	445	\$239,855
Bath	8,324	\$4,486,636
Bowdoin	3,066	\$1,649,879
Bowdoinham	2,880	\$1,552,320
Georgetown	998	\$537,922
Phippsburg	2,153	\$1,160,467
Richmond	3,393	\$1,828,827
Topsham	8,750	\$4,716,250
West Bath	1,978	\$1,066,142
Woolwich	3,065	\$1,652,035
Total	35,194	\$18,969,566

11. Assessing Vulnerability: Analyzing Development Trends

Requirement §201.6(c)(2)(ii)(C): (The plan should describe vulnerability in terms of) providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use descriptions.

Element **A.** Does the new or updated plan describe land uses and development trends?

Changes in the Economy

There are three principal economic trends within Sagadahoc County. The first is the continued uncertainty related to Bath Iron Works, Maine’s largest employer. The workforce at Bath Iron Works in January, 2011 was approximately 5,600 employees, down from 12,000 in 1990. During the 1990s the U.S. Economic Service developed a county level typology for non-metropolitan counties based on their dominant economic traits, using the categories of “manufacturing dependent”, “government dependent”, “services dependent”, and “non-specialized”. Sagadahoc was designated as “manufacturing dependent”.

The second trend is the closure of the Brunswick Naval Air Station (BNAS), located in the Town of Brunswick. Although Brunswick is not in Sagadahoc County, the geography is such that the Naval Air Station is situated between the municipalities of Bath and Topsham, Sagadahoc County’s two most populous communities. Closure of the BNAS has negatively impacted employment and population growth in the County.

The third trend is the relatively rapid commercial and retail growth in the Town of Topsham, which has transformed that community into the retail center of the southern region of mid- coast Maine. Despite this trend, development has not been in hazard prone areas so the vulnerability has not changed.

Seven of the ten municipalities in Sagadahoc County have prepared comprehensive plans that are certified by the Maine Office of Community Development as being consistent with the growth management law, and many of these can be used to support municipal zoning ordinances in the event that these communities choose to enact such controls. The following is a summary of the status of these plans:

Status of Comprehensive Plans		
Municipality	Consistency with State Requirements	Adoption Date
Arrowsic	No	1 March 1989
Bath	Yes	2 September 2009
Bowdoin	No	26 October 1991
Bowdoinham	Yes	6 June 2014
Georgetown	Yes	1 November 1993
Phippsburg	Yes	8 May 2006
Richmond	Yes	March 2016
Topsham	Yes	19 May 2005
West Bath	Yes	14 June 2006
Woolwich	No	6 May 2009

The Towns of Bowdoin, West Bath and Topsham are also considering undertaking a plan update in the near future.

Impact of Hazards on Future Development

In the event that employment should drop significantly due to trends in the manufacturing sector, there could be effects relating to all hazards. These effects include a reduced tax base to fund municipal mitigation activities, an increase in vacant structures, and increased commuting time for residents to jobs outside the county, resulting in greater reliance on the transportation infrastructure and less time available for community activities such as volunteer firefighting.

Flooding will have an impact on floodplains and on roads in vulnerable locations. This hazard will continue to have the primary impact of shutting down transportation in some areas, since it is primarily the roads that are the objects of flooding in the County. Flooded roads could impact businesses, industry, commerce and schools, and could also delay many social and emergency services. Increased high-density development, particularly in Topsham, results in areas with a high percentage of impervious surfaces, making these areas more vulnerable to flooding from surface runoff.

Severe Winter and Summer Storms will have an impact on all land areas within Sagadahoc County. These two hazards will have the primary impact of shutting down transportation and power which will, in turn, shut down businesses, industry, commerce and schools and will stop or impede social and emergency services.

All the municipalities in Sagadahoc County have joined the Federal Flood Insurance Program (FFIP) and, as a condition of participation in the program, have enacted floodplain management ordinances that limit new development in floodplain areas. There are some homes and seasonal dwellings in Sagadahoc County that are in the 100-year floodplain. As these properties are sold and mortgaged, owners may be required to upgrade these homes in order to meet the requirements of local floodplain management ordinances as well as the demands of lenders.

Wildfires will continue to have an impact on residential properties located within the County’s wildland/urban interface.

12. Multi-Jurisdictional Risk Assessment	
Requirement §201.6(c)(2)(iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction’s risks where they vary from the risks facing the entire planning area.	
Element	A. Does the new or updated plan include a risk assessment for each participating jurisdiction as needed to reflect unique or varied risks?

The following are hazards for which all areas of the county are subject to the same general risk:

- Flooding
- Severe summer and winter storms
- Wildfires (with some limited variance among the communities)

The following hazards primarily affect the coastal communities of Arrowsic, Bath, Bowdoinham, Georgetown, Phippsburg, Topsham, West Bath and Woolwich:

- Coastal flooding
- Coastal erosion

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The following hazards primarily affect the communities of Bowdoinham, Richmond, and Topsham:

- Riverine flooding

Maps

The following pages contain base maps for each of the municipalities in Sagadahoc County.