VULNERABILITY ASSESSMENT
AND
ACTION PLAN

GOULDSBORO, MAINE

October 2022

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Mill Pond © Town of Gouldsboro

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EXECUTIVE SUMMARY

A vulnerability assessment for the Town of Gouldsboro was completed to inform an action plan that will help address climate resiliency threats within the Town. Specifically, the vulnerability assessment focused on four areas of concern most impacted by climate change, including Jones Cove, Corea Harbor, Grand Marsh Bay, and South Gouldsboro. **Two of the Town's greatest vulnerabilities are the flooding of transportation infrastructure and working waterfront infrastructure.**

Gouldsboro faces many of the same coastal hazards as other Maine towns, except for those southern Maine towns with large sandy beaches and extensive estuary systems. Gouldsboro experiences strong storm surges and associated flooding from large storm events such as Nor'easters in conjunction with tidal cycles or events. Rocky shoreline bluffs along the western shores of Gouldsboro face erosion from intensified storm surges and wave action, while low-lying salt marshes along the southeastern shores of Gouldsboro face inundation from sea level rise that will continue to impact infrastructure.

This report aims to provide the Town with action items and necessary information to start moving forward with addressing climate resiliency vulnerabilities. The action plan should be viewed as a living document, meaning the Town should updated it regularly as progress is made or adapt it as challenges or new issues arise. The graphic below illustrates an example pathway of moving forward to implement action items.

ADDRESSING CLIMATE RESILIENCY THREATS IN GOULDSBORO

This is an example pathway of moving forward to implement climate resiliency measures. This pathway is an evolving process between planning and implementation.

General Process	Gouldsboro Example
Gain Town support by using data to educate the public on the effects of climate change in their community. Involve the Town.	Establish a committee of stakeholders committed to moving climate resiliency actions forward. Continue engaging the public such as through the Gouldsboro Shore website.
Next, work to build a consensus on an action plan and short and long-term priorities. Establish funding strategy.	Assess priorities based on the action plan presented in this document, bringing in community members, the Town, and other stakeholders. Consider joining the Community Resilience Partnership through the State of Maine to access state funding opportunities.
Use existing action items to inform next steps and determine planning gaps: conduct feasibility assessments in high priority areas; create Town-wide Climate Action Plan, etc. and engineering design work in High Priority Areas.	Conduct feasibility assessments of climate resiliency options for priority areas, such at the Corea Harbor and Gouldsboro Shore Road. Secure funding for engineering designs for infrastructure upgrades to meet resiliency standards.
Begin engineering designs on chosen infrastructure priorities, complete permitting for construction work, secure funding for implementation work, etc.	Complete engineering designs using state Climate Resiliency Partnership funding, for example to upgrade undersized culverts on Corea Road to accommodate increased tidal flow and elevate the roadway to withstand 1.6 feet of sea level rise.
Begin implementation. Assess successes and lessons learned along the way. Update the action plan.	Secure federal funding to complete upgrades on Corea Road. Assess process, and use lessons learned in other priority areas of the Town.

INTRODUCTION

This report provides an action plan with recommended next steps to enhance the Town of Gouldsboro's coastal hazard resilience. Recommended action items are based on the existing hydrologic and infrastructure conditions within the Town and identified critical areas of vulnerability due to predicted sea level rise (SLR), storm surge, and extreme precipitation events. FB Environmental Associates (FBE), with assistance from the Town, compiled information on existing conditions within the Town, including the location of critical infrastructure. FBE then over laid predicted future coastal and freshwater flooding extents with the location of critical infrastructure to identify vulnerabilities.

WHAT'S BEING DONE IN MAINE?

As coastal hazards become increasingly severe in the northeast, the State of Maine, and the coastal communities within it, have been investing in understanding and developing strategies for reducing climate vulnerabilities. In 2013, a vulnerability assessment was published for 19 towns along the southern Maine coast, from Kittery to Brunswick. The report identified high priority vulnerabilities to "both locally and regionally important public infrastructure" (GPCOG, 2013). This early effort signified an important step towards planning for SLR and coastal hazards at a regional scale and provided a framework for Maine communities to build upon.

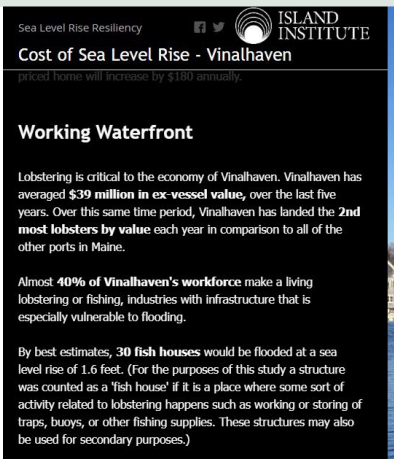
The Maine Coastal Program and Maine Department of Agriculture, Conservation and Forestry released the Maine Flood Resilience Checklist in 2017. The checklist is a non-regulatory assessment tool developed to help coastal communities examine local flood risk, evaluate vulnerability to flood hazards, and identify specific actions for enhancing community-wide flood resilience – the ability to avoid or withstand harm and to recover quickly when damage does occur. In 2020, the Maine Climate Council (MCC) published the Maine Won't Wait Climate Action Plan, which indicates that the State should commit to managing for Highest Astronomical Tide (HAT) plus 1.5 feet of SLR by 2050 and HAT + 3.9 feet of SLR by 2100 and should consider preparing to manage for 3.9 feet by 2050 and 8.8 feet by 2100 (MCC, 2020). These State-wide initiatives have helped provide context for municipalities to plan for climate resiliency.

Recently, more detailed studies have been done to help build coastal resilience in southern Maine. The report, Tides, Taxes, and New Tactics, was published in 2021 and provides the towns of Kennebunk, Wells, and York with recommendations to address coastal flooding hazards (SMPDC, 2021). The study included a GIS analysis of vulnerability to SLR and storm surge, as well as a socio-economic analysis of the economic impacts of these coastal hazards.

The Island Institute recently published the first component of a three-part Economic Impact Study on The Cost of Sea Level Rise – Vinalhaven Edition (Island Institute, n.d.). The study walks through the challenges faced by an island community and discusses the SLR threat to the sustainability of the coastal Maine, including a discussion of property flooding, property tax burden, impacts to the working waterfront, and effects on ferry transportation and road infrastructure.

While Gouldsboro does not face the same coastal hazards as more low-lying areas of southern Maine, it does experience strong storm surges and associated flooding from large storm events such as Nor'easters in conjunction with tidal cycles or events. It is important for coastal communities, such as Gouldsboro, to conduct detailed vulnerability assessments to properly prepare for future SLR and flooding scenarios.

Left; The Maine Climate Council Four-Year Plan is intended to help guide municipal actions. Right; The Island Institute developed a story map on The Cost of Sea Level Rise on Vinalhaven*, providing a valuable example for Midcoast Maine communities.*



ACTION PLAN

OVERVIEW

The action plan was developed based on results from the vulnerability assessment conducted for the Town of Gouldsboro (presented in the second half of this report). The action plan provides recommendations for next steps to address the vulnerabilities identified within the Town.

Key steps to addressing a municipality's coastal vulnerabilities include developing/defining a team or committee to manage the effort, identifying and prioritizing strategies and action items, and identifying and securing the funding necessary to execute the plan. While each step of the process is equally important, this report focuses on providing information on the identification of resiliency strategies and action items.

For example, two of the Town's greatest vulnerabilities are the flooding transportation infrastructure (roads and culverts), and impacts to working waterfront infrastructure. The action plan prioritizes recommendations based on extent of inundation under HAT + 1.6 feet of SLR and HAT + 3.9 feet of SLR and severity of impacts to infrastructure.[1] The Town may choose to prioritize action items differently based on factors such as funding availability and stakeholder interest.

Coastal resiliency strategies generally fall into three main categories: protect, accommodate, and managed retreat (Dronkers et al., 1990). The actions identified in the action plan include all three strategies.

> Protection strategies aim to defend or stabilize an area against SLR, storm surge, and flooding. This strategy uses engineered solutions to protect resources and infrastructure in their existing locations and does not require modification of the resources themselves. Solutions can include both conventionally engineered and nature-based techniques. Examples of protection strategies include dikes, seawalls, breakwaters, living shorelines, and wetland restoration efforts.
>
> Accommodate strategies involve the adaptation or modification of existing and new infrastructure to decrease their vulnerability to coastal flooding and SLR. Some examples of this include raising buildings and roads, floodproofing buildings, and raising existing seawall heights.
>
> Managed retreat strategies involve the strategic relocation of existing infrastructure to less vulnerable areas. This management strategy also includes limiting new development in vulnerable areas such as those impacted by SLR. Examples include the relocation of public facilities, road and utility infrastructure, and residential homes.

Different types of coastal resilience measures are necessary for different types of vulnerabilities. A suite of resiliency strategies may be required to properly mitigate the impacts of climate change and SLR in the Town of Gouldsboro. The Town, including municipal personnel and public community members, must assess which resiliency strategies are best suited for their goals, budget, and preference.

ACTION PLAN TABLE

The following action plan table is organized by priority and location, with high priority items shaded in red, moderately high priority items shaded in orange, moderate priority items shaded in yellow, and low priority items shaded in gray. For additional details on each site, refer to the vulnerability assessment starting on page 9 and the map suite in Appendix A.

[1]Data on the Highest Astronomical Tide (HAT) and flood inundation boundaries due to SLR and storm surge were collected from the Maine Geological Survey (MGS), an entity of the Maine Department of Agriculture, Conservation, and Forestry. Inundation boundaries of the three different SLR scenarios that best matched the MCC recommended planning scenarios (HAT+1.5, +3.9, and +8.8 feet) were obtained. The MGS SLR scenarios are based on the amount of elevation rise above the HAT. The scenarios used in this analysis included HAT+ 1.6 feet, HAT+ 3.9 feet, and HAT+ 8.8 feet. Although MCC recommends using 1.5 feet of relative sea level rise as a planning threshold for 2050, 1.6 SLR is represented here because that is the data available.

Location	Status	Recommended Action	Suggested Timeline	Responsible Party	Cost Reasoning*
Highest Priority: Planning for HAT + 1.6 feet sea level rise (SLR) by 2050; impacts from a 100-year storm event; and for HAT + 3.9 feet SLR for key infrastructure only.					
The highest priority areas were chosen based on extent of inundation under 1.6 feet of SLR and 3.9 feet of SLR, and during 100-year storm events, and severity of impacts to infrastructure. The following actions are prioritized based on these factors. The Town may choose to prioritize differently based on factors such as funding availability and stakeholder interest.					
Corea Harbor Marina, Docks, and Working Waterfront	Corea Harbor is a highly vulnerable area. The harbor includes working waterfront (commercial fishing docks, Lobster Co-ops, lobster pounds, and fishing infrastructure), restaurants & tourism (such as "Lunch on the Wharf" and Lobster Boat Tours) and some residential properties. This infrastructure is at risk of inundation during a 100-year storm event, 1.6+ feet of SLR, or Category 1-2 hurricanes. Increased SLR at 3.9 feet and 8.8 feet scenarios (or Category 3-4 hurricanes), create deeper flood waters and further inland inundation in Corea Harbor, threatening are more properties and roads.	With such a variety of uses in Corea Harbor, numerous approaches are required. We recommend a harbor-wide feasibility study to evaluate the best option specific to Corea Harbor. Actions identified in a study may include:	Begin securing funding for feasibility studies immediately (0-2 years). Implementation should occur as soon as next steps are determined and designed, and funding is available (1-10+ years).	Town of Gouldsboro; stakeholders in Corea Harbor. We recommend establishing a Corea Harbor subcommittee (sometimes called a Design and Resiliency Team) or community leader to lead grant application efforts and coordinate between multiple stakeholders.	Feasibility studies for full-scale management efforts for all of Corea Harbor may cost in the range of $50,000 to $150,000 to complete the study. The outcome of the study would be a clear and effective jumping off point for applying for and using grant funds.
		Take action to protect the working waterfront by ensuring access by fishermen even if traditional access points or right-of-ways are inundated, flood proofing buildings, elevating infrastructure (including loading docks, bait and gear storage, cold storage, commercial hoists, forklifts, etc.), considering a capital reserve fund to help offset increased costs of maintaining/repairing fishing infrastructure if damaged during storm surges or inundation, considering managed retreat (relocation) of fishing infrastructure, replacing gray infrastructure (man-made hardscaping) with green infrastructure (living shorelines, natural coastal habitats, floodplain restoration).				
		Take action to protect restaurant/tourism infrastructure by flood proofing/elevating buildings, considering managed retreat.			
		Take action to address residential property vulnerabilities by flood proofing buildings (consider mandating flood proof standards through policy/ordinances in the long term), considering managed retreat, replacing and relocating septic systems out of inundated areas, replacing hardscaping (seawalls) with natural coastal habitats (bioengineering, living shorelines).	Education and outreach to homeowners should occur immediately. Implementation should begin immediately and continue long term (0-10+ years). Mid-range and long term land use ordinance changes should be considered and drafted to require buildings to be able to withstand future sea level rise and flooding (refer to regulatory action items).	Residential property owners.	NA
Corea Road	At 1.6 feet of SLR, Corea Road will experience nuisance flooding at the least, with potential for dangerous washouts, unsafe driving conditions, and damage occurring. During a 100-year storm event, portions of Corea Road will be flooded. With increasing SLR at 3.9 feet projections, Corea Road will be inundated by 2-8 feet of water, rendering it unpassable. These locations along Corea Road are highest priority because they will leave portions of the town inaccessible to services:	The following actions should be prepared for by securing funding and completing engineering designs. Roadway modifications can and should be done during natural infrastructure life cycle replacements. For example, if a Corea Road culvert is going to replaced in 3 years anyways, at that point the culvert should be enlarged for higher tidal flows and the roadway should be elevated to accommodate SLR of 1.6 feet.	Begin securing funding and engineering designs immediately. Incorporate these efforts into the Town's schedule of infrastructure upgrades and replacements. Consider moving these upgrades up in the Town's schedule, if possible. Having shovel-ready designs is valuable when securing grant funding.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000-$75,000 (or more, depending if the designs include culvert and road elevation redesign).*
	The Corea Road - Grand Marsh Bay Road intersection is projected to be flooded during a 100-year storm event and has two cross culverts that may be unable to accommodate increased tidal flows under SLR scenarios greater than 3.9 feet. This area is very important to plan for resilience because inundation, damage, etc. would cut off this eastern peninsula of Gouldsboro from emergency services.	This roadway should be elevated and the culverts should be replaced to accommodate elevated tidal flows during high precipitation events (e.g., the culverts should be able to accommodate a situation where a heavy rain event occurs at the same time as a high tide during 3.9 feet of SLR).			

**Cost estimates for engineering designs should be treated as rough estimates intended to help the Town plan for funding needs. FBE recommends working directly with engineers and contractors to refine cost estimates for both engineering designs and construction when putting together funding applications.*

Location	Status	Recommended Action	Suggested Timeline	Responsible Party	Cost Reasoning*
Corea Road (continued)	Corea Road prior to the intersection with Cranberry Point Road and Francis Pound Road is projected to be flooded during a 100-year storm event or by 3.9 feet SLR, rendering Cranberry Point inaccessible. Francis Pound Road would also be inaccessible.	The roadway should be elevated. This intersection of roads is also where the high tide line connects to 100-year and 500-year floodplains, so high flows during storm events may be possible here and drainage infrastructure should be engineered with this consideration.	Begin securing funding and engineering designs immediately. Incorporate these efforts into the Town's schedule of infrastructure upgrades and replacements. Consider moving these upgrades up in the Town's schedule, if possible. Having shovel-ready designs is valuable when securing grant funding.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $30,000 - $50,000.*
Grand Marsh Bay Road	Similar to Corea Road, Grand Marsh Bay Road is within the 100-year floodplain, and with increasing SLR at 3.9 feet projections, it will be inundated by 2-6 feet of water in the deepest locations, rendering it impassable at the southern tip of the long marsh. This location is a high priority because when flooded, in combination with Corea Road, the entire eastern peninsula of Gouldsboro will be inaccessible. At 8.8 feet of SLR, this portion of Gouldsboro to the east would effectively become an island.	Elevate the roadway, ensure tidal flow can accommodate sea level rise, and protect the floodplain against development.	Begin securing funding and engineering designs immediately; incorporate these efforts into the Town's schedule of infrastructure upgrades and replacements. Consider moving these upgrades up in the Town's schedule, if possible.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000 - $75,000.
Crowley Island Road	Crowley Island Road leading out to Youngs Point is projected to be flooded during a 100-year storm event or by 3.9 feet SLR, rendering Crowley Island Road/Youngs Point inaccessible. Under 8.8 feet of SLR, much of the front side of the island (southeast) will be inundated.	Elevate the roadway and ensure tidal flow can accommodate sea level rise.	Consider including this in the Corea Harbor feasibility study.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000 - $75,000 .
Main Street	A culvert located on Main Street along the west edge of Prospect Harbor would be affected by a 100-year storm event with increased waves along the coast. Culverts that are undersized for storm events can cause flows to back up or cause road washouts. This stretch of Main Street will also be affected by SLR greater than 3.9 feet, including buildings in this area.	Assess culvert for ability to withstand 100-year storm events. Consider upgrading culvert. Buildings should be flood-proofed or managed retreat should be considered.	Assess (and possibly upgrade) culvert in the short term (0-2 years). Elevate roadway in the next 5-10 years.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $75,000 - $100,000 .
Bunker Pound Road	Bunker Pound Road is expected to experience up to 2 feet of flooding under SLR of 1.6 feet, with the extent of the road under water increasing under 3.9 feet SLR and greater. While this road is relatively short, it should still be considered by the Town for climate resiliency actions as there are residences and working waterfront infrastructure that will be impacted.	Elevate the roadway and protect working waterfront.	Take steps to protect the working waterfront immediately. Elevate roadway in the next 5-10 years.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000 - $75,000.
Clinic Road Bridge	The Clinic Road Bridge that passes over the Jones Pond outlet to Jones Cove is within the 100-year floodplain. Damage or impassibility of the bridge due to SLR would limit accessibility to Winter Harbor. This bridge is not projected to be at risk from SLR.	Assess bridge for ability to withstand increased flows during heavy precipitation events.	2-5 years	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $30,000 - $50,000 .

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Location	Status	Recommended Action	Suggested Timeline	Responsible Party	Cost Reasoning*
Guzzle Road	Two important bridges on Guzzle Road - one over West Bay Pond's outlet and one that crosses over the northern tip of the pond - are within the zone flooded by a 100-year storm event. Flood events may cut off access to Guzzle Road and limit access to numerous residences.	Assess bridges for ability to withstand increased flows during heavy precipitation events.	2-5 years	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000 - $75,000.
Redding Road	Redding Road will be inundated by SLR of 1.6 feet as it crosses the tidal marsh associated with Tucker Creek. While there are only a few residential properties located beyond the point of inundation, the depth and extent of the inundation will increase at 3.9 feet SLR or greater.	Elevate roadway. This effort will likely need to be resident-led as it is a private road.	2-5 years	Residents	NA
Medium Priority: Planning for 3.9 feet Sea Level Rise for all vulnerabilities by 2100					
Many of the vulnerabilities addressed above are exacerbated by additional feet of projected sea level rise, as noted in the "status" column. The moderate priority action items listed below are areas that are not projected to be impacted notably by 1.6 feet SLR or 100-year storm events, but will be at 3.9 feet SLR.					
South Gouldsboro	The South Gouldsboro area along Shore Road and Seaswept Way Road will be impacted minimally by 1.6 feet SLR (nuisance flooding possible) but increasingly impacted and inundated by 3.9 feet SLR or greater. While extensive inland inundation is not projected in this area due to a steeper shoreline, the area is still vulnerable to impacts to shoreline infrastructure from SLR and storm surges.	Assess feasibility of protecting the shoreline using green infrastructure/living shoreline techniques to reduce vulnerability to erosive wave action. Conduct outreach/education to landowners on monitoring potential bluff erosion. Take action to protect the working waterfront by assessing inundation impacts to Bunkers Cove boat launch, ensuring access to the launch for fishermen, flood proofing/ elevating infrastructure, and considering managed retreat (relocation) of fishing infrastructure. Elevate the roadway.	Steps to protect the working waterfront and boat launch should begin in the short term. Shoreline protection and roadway elevation are long term action items.	Town of Gouldsboro; Landowners	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $75.000 - $100,000.
	Impacts will include flooding or damage to the dock infrastructure in Bunkers Cove, flooding of the Bunkers Cove boat launch (starting under 1.6 feet SLR), and shoreline erosion and impacts from storms.				
	Residential shoreline properties may experience impacts to septic systems depending on placement. Beyond 3.9 feet of SLR, shoreline properties are projected to experience inundation at 8.8 feet SLR.	Take action to address residential property vulnerabilities, such as: flood-proof buildings (consider mandating flood proofing to meet SLR standards through policy/ordinances), consider managed retreat, replace and relocate septic systems out of inundated areas, replace hardscaping (seawalls) with natural coastal habitats (bioengineering, living shorelines).	Education and outreach to homeowners should occur immediately. Implementation should begin immediately and continue long term (0-10+ years). Mid-range and long term, land use ordinance changes should be considered and drafted to require buildings to be able to withstand future sea level rise and flooding.	Residential property owners.	NA
Jones Cove	The steeper shorelines of Jones Cove offer some protection against the impact from SLR inundation. However, the area is still vulnerable to shoreline erosion from wave action and storm surges.	Assess feasibility of protecting the shoreline using green infrastructure/living shoreline techniques to reduce vulnerability to erosive wave action. Conduct outreach/education to landowners on monitoring potential bluff erosion.	Shoreline protection and roadway elevation are long term action items.	Landowners	NA
	Some landowners along Jones Cove will likely experience shoreline erosion on their property. The Clinic Road Bridge is within 100-year floodplain and increased precipitation events may impact the stream crossing (refer to Clinic Road bridge action item above).				

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Location	Status	Recommended Action	Suggested Timeline	Responsible Party	Cost Reasoning*
Roads	Additional roads that will be inundated under 3.9 feet SLR that are not already discussed: Schieffelin Point Road Lighthouse Point Road	Elevate roadway. Ensure stream crossings and culverts can accommodate SLR.	Plans to improve resiliency of these roadways should be incorporated into the Town's schedule of infrastructure upgrades and replacements, with the timeline depending on the next cycle update.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000 - $100,000.
Culverts	Culverts will be increasingly affected by SLR and extreme precipitation events. Three culverts are within the 100-year floodplain (one on Main Street in Prospect Harbor and two on Corea Road - refer to actions under the highest priority items). Under 8.8 feet SLR or greater, 13 culverts are inundated (along Corea Road, West Bay Road, Grand Marsh Bay Road, Schoodic Drive) - though the culverts will be impacted earlier when they are unable to accommodate tidal flow and/or large storm events.	Some culverts will need to be upgraded if the road is affected by 1.6 or 3.9 feet SLR (as noted earlier in the table). However, a Town-wide culvert assessment is recommended to determine where and when culverts that are impacted by tidal flow under rising sea levels should be upgraded.	Town-wide culvert assessment should be completed in the long term. Priority culverts (in above actions) should be upgraded in the short term.	Town of Gouldsboro, Consultant	A Town-wide culvert assessment may cost in the range of $50,000 to $100,000 to complete the study, depending on level of engineering designs and expertise involved. The outcome of the study would be a clear and effective jumping off point for applying for and using grant funds.
Lower Priority Action Items to consider for hazard planning and planning for 8.8 feet SLR inundation.					
Gouldsboro Bay	8.8 feet of SLR would begin to inundate and affect houses along Gouldsboro Bay such as along Paul Bunyon Road and Point Francis Road. These are not focus areas of this vulnerability report and are not high priority action items, however, policy and awareness action items can be taken now to help prepare for future impacts.	Educate homeowners and consider land use policies to prevent development in these areas that will be vulnerable to inundation in the future.	Long term	Town of Gouldsboro	NA
Roads	Additional roads that will be inundated under 8.8 feet that are not already discussed: Peninsula Shore Road (located off Paul Bunyon Road)	Elevate roadway. Ensure stream crossings and culverts can accommodate SLR.	Plans to improve resiliency of these roadways should be incorporated into the Town's schedule of infrastructure upgrades and replacements, with the timeline depending on the next cycle update.	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $30,000 - $50,000.
Grand Marsh Bay to Corea Road	Portions of Grand Marsh Bay and Corea Harbor will experience inundation under 1.6 feet SLR and 3.9 feet SLR. Under 8.8 feet SLR and during Category 2-4 hurricanes, floodwaters will disconnect this eastern portion of Gouldsboro. During a Category 4 hurricane, the channel depth is projected to be 6-9 feet.	Consider planning for these severe inundation scenarios when completing the high priority upgrades in this area.	Long term	Town of Gouldsboro, Consultant/Engineer	Engineering designs are needed to estimate construction costs. Engineering designs may cost in the range of $50,000 - $100,000.
Buildings	Beyond the buildings and areas mentioned in the above priority recommendations, some buildings are projected to be inundated during severe (Category 3 - 4) hurricanes. These mainly include buildings near Prospect Harbor, the Prospect Harbor lighthouse, the American Aquafarms building (formerly Maine Fair Trade Lobster building), the Corea Harbor Lobster Co-op, the Catch your Dinner Lobster Tours building, and the Lunch on the Wharf building.	Many of these buildings should be included in the Corea Harbor resiliency planning efforts. Other buildings should be flood proofed, and future development should be discouraged in areas projected to be impacted by intense storms.	Long term	Landowners	NA

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Location	Status	Recommended Action	Suggested Timeline	Responsible Party	Cost Reasoning*
Regulatory and Land Use Policy Priorities					
Many of these policies provide additional detail to action items listed above. These action items are based on Gouldsboro's identified vulnerabilities to SLR and flooding.					
Town-wide	The Town of Gouldsboro should adopt SLR planning standards into planning efforts. We recommend employing a scenario-based approach to planning for sea level rise and to utilize scenarios consistent with those identified in the Maine Won't Wait Climate Action Plan. Specifically:		Short Term	Town of Gouldsboro	NA
		Commit to manage for an intermediate SLR scenario of 1.5** feet by 2050 and 3.9 feet by 2100 (over a baseline year of 2000).			
		Prepare to manage for a 8.8 feet by 2100, depending on the risk tolerance of different types of infrastructure.			
		Use sea level rise planning standards to update and inform the Town's Hazard Mitigation Planning. This is important because currently residents near Corea Harbor are at risk of being out of range of emergency services if Corea Road and/or Grand Marsh Bay Road are inundated.			
		Completing the Maine Flood Resilience Checklist from the Maine Coastal Program can help the town understand and categorize their vulnerabilities across all sectors of the Town. The checklist will be complementary to this vulnerability assessment.			
Town-wide	The Town of Gouldsboro should incorporate sea level rise considerations into municipal capital improvement and investment planning.		Short Term	Town of Gouldsboro	NA
		Construction, reconstruction, and repair of roads and bridges should take drainage and elevation into account but also stabilization and armoring of vulnerable road shoulders and embankments.			
		Move high priority areas up in the schedule of infrastructure replacement.			
		When infrastructure is replaced due to an end in its natural lifetime, upgrade it to meet future resiliency standards.			
		Adopt a policy that limits municipal expenditures in flood hazard areas, unless expressly for adaptation, mitigation, or resilience measures.			
Town-wide	Expand upon and improve flood mapping. Work to increase and improve FEMA FIRM floodplain mapping to cover the entirety of Gouldsboro. Particularly in the Birch Harbor sub-watershed area.		Short Term	Town of Gouldsboro	NA
Town-wide	Develop land use policies the reduce, restrict, or discourage development in areas of Gouldsboro that are vulnerable to future inundation. Require or encourage existing development in these areas to improve their resiliency. Specifically for the Town of Gouldsboro, we recommend considering these avenues:		Moderate - Long Term	Town of Gouldsboro	NA
		Prohibit new development in areas identified as vulnerable to the impacts of sea level rise, storm surges, and/or flood hazards.			
		Integrate flood considerations in road development standards by incorporating sea level rise and coastal flood considerations into municipal roadway standards. For example, one component may be that road development projects must demonstrate that surface flooding due to projected sea level rise and storm surge is mitigated.			
		Coastal resilience overlay zoning district: Implement an overlay district in coastal areas of particular risk for the purpose of applying development standards to enhance resilience.			
Town-wide	Nature-based solutions and green infrastructure should be prioritized where appropriate. Nature-based solutions provide effective and lower-cost protection for climate-change-related challenges while restoring coastal and marine habitats. For example, green infrastructure helps with stormwater management, and "living shorelines" are projects constructed with plants, oyster shells, and other natural materials to protect against coastal erosion.		Ongoing	Town of Gouldsboro	NA
		Restore, create, or expand natural coastal habitats to provide natural flood and storm protection by intentionally removing or altering existing man-made shoreline structures such as bulkheads, seawalls, and revetments.			
		Coastal flooding and marsh migration area setbacks: Increase shoreland zoning setbacks and/or apply to areas specifically impacted by sea level rise and storm surge. Apply to marsh migration areas.			

**Cost estimates for engineering designs should be treated as rough estimates intended to help the Town plan for funding needs. FBE recommends working directly with engineers and contractors to refine cost estimates for both engineering designs and construction when putting together funding applications.*

*** The Maine Won't Wait recommendations of 1.5 feet of SLR does not align exactly with available data projections from the Maine Geological Survey. For this assessment and action plan, FBE used the available 1.6 feet SLR projection, 3.9 feet SLR projection, and 8.8 feet SLR projection for benchmarks.*

VULNERABILITY ASSESSMENT

Maine's coastal communities are vulnerable to flooding hazards related to SLR, storm surge, and extreme precipitation events. These flooding hazards threaten critical facilities, roadways and supporting transportation infrastructure, town infrastructure, private property, and natural resources. This poses challenges to the security, health, and welfare of citizens, and threatens a stable and viable economic future. The frequency and severity of coastal flooding in Maine has increased in the last decade and is predicted to continue to rise (MCC STS, 2020). Riverine (freshwater) flooding is also expected to increase in response to increases in extreme precipitation events in the northeastern US (New Hampshire Coastal Flood Risk Summary, 2019). This is partly due to the projected increase in short, heavy precipitation events – when excess rain falls within a short period of time (i.e., several inches within a few hours) – drainage infrastructure such as culverts cannot handle the large volumes of water. These pressures are exacerbated in coastal communities where infrastructure needs to handle increased precipitation and rising tides simultaneously. For example, existing two-way tidal culverts may not be able to handle the concurrence of both the higher flows of rising tides and increased stormwater drainage volumes. The risks from flooding and associated vulnerabilities will significantly increase as storms become more frequent and intense and as sea levels rise. Therefore, it is important for coastal communities to understand the vulnerabilities and risks associated with future flood hazards in their town so that they can plan accordingly and develop an action plan that will enhance their resilience.

A vulnerability assessment provides critical information on local resources, existing and future flood hazards, and vulnerabilities within a community. It also identifies and prioritizes strategies for mitigating risk and enhancing a community's resilience to flooding. The Town of Gouldsboro has a valuable opportunity to identify and implement planning, policies, and strategies today that will reduce the Town's vulnerability and protect its natural, social, and built assets in the future as local threats of coastal flood hazards become more severe.

A local restaurant located on the wharf in Corea Harbor. © D. Philly

Corea Harbor © Town of Gouldsboro

South Gouldsboro © Town of Gouldsboro

The shoreline along Prospect Harbor. ©M. Kelly

METHODS

The vulnerability assessment conducted by FBE included compiling data from local, state, and federal sources and analyzing the collected data using ArcGIS Pro Geographic Information System (GIS) software. Information regarding the data sources and the GIS analysis methods are presented below.

DATA SOURCES

Existing Conditions

Existing geographic, hydrologic, infrastructure, and natural resource data were obtained from a variety of sources. Hydrologic data included waterbody and stream boundaries (i.e., flowlines) acquired from the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) and wetland boundaries acquired from the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) (See map on Page 17). Additionally, the USGS StreamStats software was used to estimate the boundaries and basin characteristics (i.e., drainage area, mean elevation, precipitation estimates, peak-flow statistics, etc.) of the major sub-watersheds within the Town. These sub-watersheds included the drainages of Jones Cove, Winter Harbor, Birch Harbor, Prospect Harbor, Grand Marsh Bay, Corea Harbor, West Bay Pond, and Chicken Mill Pond (See map on Page 18).

Data on the location of existing infrastructure within the Town was obtained from the Maine GeoLibrary. These infrastructure data included the location of roads, bridges, culverts, closed municipal landfills, fire stations, schools, boat launches, and DEP Pollutant Discharge Elimination System (PDES) Outfalls. Additionally, the location of buildings within the Town was acquired from the Microsoft Building Footprints database (See map on Page 19).

Vulnerability Analysis Data

Data on the Highest Astronomical Tide (HAT) and flood inundation boundaries due to SLR and storm surge were collected from the Maine Geological Survey (MGS), an entity of the Maine Department of Agriculture, Conservation, and Forestry. Inundation boundaries of the three different SLR scenarios that best matched the MCC recommended planning scenarios (+1.5, +3.9, and +8.8 feet) were obtained. The MGS SLR scenarios are based on the amount of elevation rise above the HAT. The scenarios used in this analysis included HAT+ 1.6 feet, HAT+ 3.9 feet, and HAT+ 8.8 feet. Although MCC recommends using 1.5 feet of relative sea level rise as a planning threshold for 2050, 1.6 SLR is represented here because that is the data available. Other MGS scenarios that are available, but were not included in this analysis are HAT+1.2 feet, HAT+6.1 feet, and HAT + 10.9 feet.

Data on flood inundation boundaries due to Category 1, 2, 3, and 4 hurricanes were obtained from the MGS Sea Lake and Overland Surges (SLOSH) dataset. The SLOSH model predicts inundation due to hurricanes during mean high tide.

Data on the inundation boundaries of the flooding of inland freshwaters and coastal waters due to extreme precipitation events were obtained from U.S. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMS). FEMA Flood Hazard Areas present within the Town included the 100-year (1% annual chance event) floodplain and 500-year (0.2% annual chance event) floodplain. The title, “100-year event”, can be misleading given that during a 30-year planning period, the chance of a 100-year storm event occurring is approximately 26%. Areas of 100-year floodplain are designated as zones A, AE, or VE. Zones A and AE refer to the inland areas within the 100-year floodplain and Zone VE refers to coastal areas within the 100-year floodplain that have an additional hazard due to storm waves (See map on Page 13).

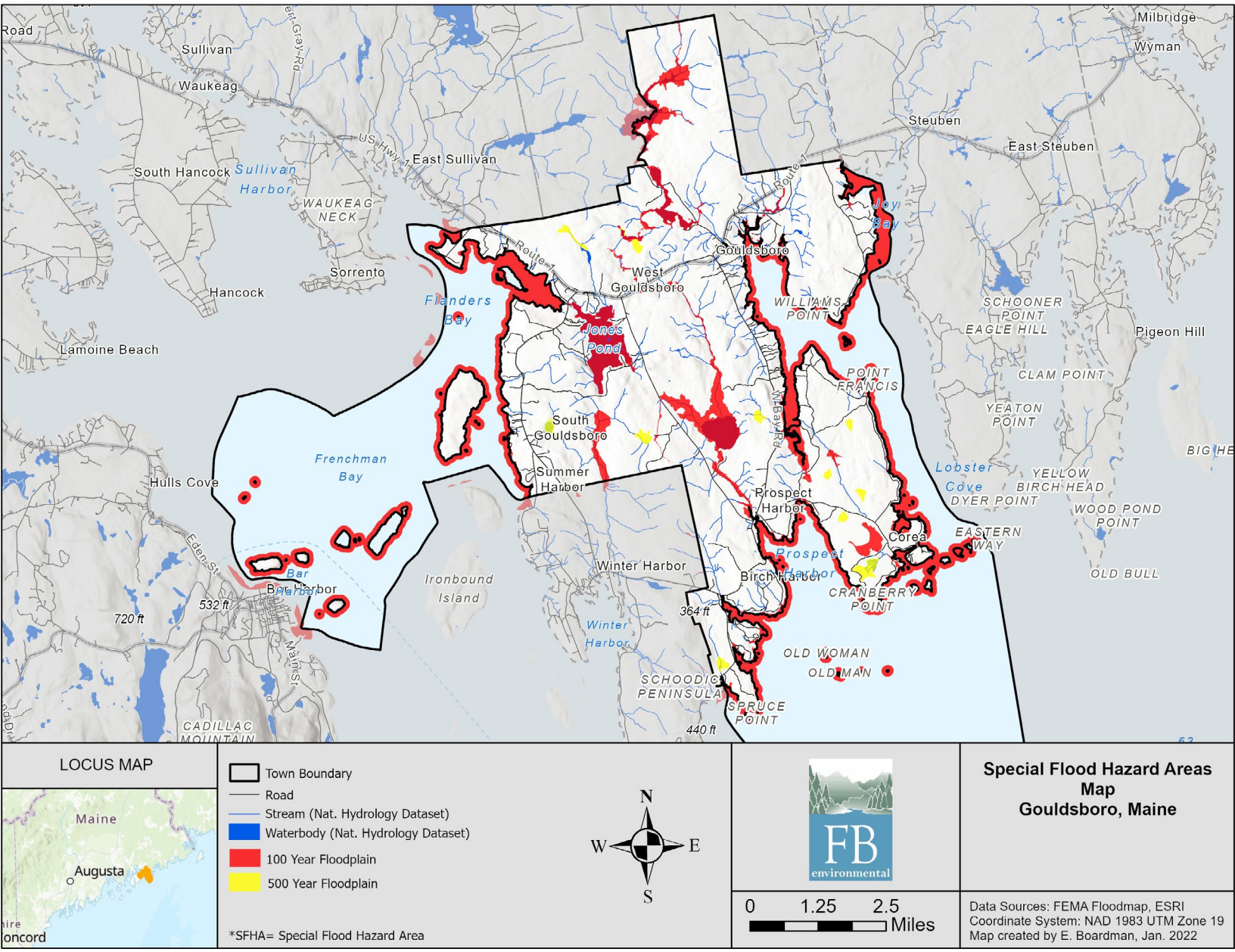
© Town of Gouldsboro

It appears that the FEMA Flood Hazard Areas are not comprehensive for the entire Town. The lack of completed mapping of 100-year floodplains within the Town is apparent within the Birch Harbor sub-watershed. The stream network that drains to Birch harbor is not mapped as 100-year floodplain by FEMA. However, two of the tributaries in this area are mapped as 100-year floodplain within the Town of Winter Harbor, but the floodplain boundary ends abruptly at the Gouldsboro Town line. This finding, along with the complete destruction of a section of Route 186 and the culvert that drains to Birch Harbor during a large precipitation event in 2021, suggests that portions of this drainage network are well within the 100-year floodplain, but are not mapped as such.

GIS ANALYSIS

The vulnerability assessment was completed using GIS software to overlay extreme weather and sea level rise datasets (SLR scenarios, SLOSH, and FEMA Flood Hazard Areas) with mapped existing infrastructure features within the Town. This allowed for the identification and quantification of locations where predicted coastal hazard areas intersect with critical existing infrastructure. Infrastructure features that overlapped with areas of inundation in the three datasets were exported and geospatial analysis was then used to determine the total length, area, or number of inundated infrastructure features within the Town boundary. Specifically, the vulnerability assessment focused on four areas of concern most impacted by climate change, including Jones Cove, Corea Harbor, Grand Marsh Bay, and South Gouldsboro. The focus areas were chosen based upon direct input from the project Steering Committee.

The Town of Gouldsboro has approximately 55 miles of coastline, which includes low-lying marshes as well as areas with steeper vertical relief.



RESULTS

The results presented here are based on projections using the best available science and data but should be viewed as approximations that can assist with identifying needed actions to increase Gouldsboro's climate resilience. Projected impacts may underestimate vulnerabilities. For example, sea level rise predictions identified by the MGS are based on historical sea level rise data. Given that sea level rise and storm surges are becoming increasingly severe, these predictions may ultimately underestimate the severity or timeline of inundation by sea level rise. For this reason, the State of Maine suggests municipalities commit to manage for 1.5 feet of SLR by 2050 and 3.9 feet of SLR by 2100, but prepare to manage for 3.9 feet of SLR by 2050 for low-risk-tolerant infrastructure (note that 1.6 feet of SLR was used in place of the 1.5 feet SLR due to availability of data, as discussed in the methodology section).

FEMA FLOOD RISK

According to the FEMA data, approximately 2,743 acres of land within the Town are inundated during a 100-year flooding event (Zones A, AE, and VE), equating to approximately 9% of the Town's land area. The most significant areas of flooding within the Town include the southern portion of Grand Marsh Bay, the area to the north of Forbes Pond, the southern extent of the peninsula that separates Prospect Harbor and Gouldsboro Bay, and along Mill Stream (south of Jones Pond). Approximately 7,417 linear feet of public road are modeled to be inundated during a 100-year storm event. Approximately 89 buildings are projected to be inundated. Again, it is important to note that there is about a 26% chance of a 100-year storm event occurring over the next 30 years.

Culverts washed out along Route 186 in the Village of Birch Harbor during a flooding event on June 9, 2021. © Dale Church

Inland freshwater flooding during a 100-year storm event (Zones A and AE) would inundate three bridges, two cross culverts, and one PDES outfall within the Town. Two of the inundated bridges are located on Guzzle Road, one that crosses the pond's unnamed outlet stream and one that crosses over West Bay Pond. The third bridge is located on Clinic Road, to the north of Barclays Landing. The two cross culverts are both located on Corea Road just to the east of Grand Marsh Bay Road. Cross culverts are defined by Maine DOT as "pipes or structures that have a span of less than five feet or multiple pipes or other structures with a combined opening of less than 20 square feet in area".

Table 1. Summary of features inundated by the FEMA flood zones.

Flood Zone	Area of land (acres)	Roads (linear ft)	Buildings	Boat Launches	Bridges	Cross Culverts	PDES Outfalls
A	1,891	1,484	3	0	3	0	0
AE	328	4,434	40	0	0	2	1
VE	524	1,499	46	1	0	1	1
500 Year Floodplain	284	0	0	0	0	0	0

Flooding along the coastline, with the added inundation due to waves produced during a 100-year storm event (Zone VE), would impact an additional culvert along Main Street, west of Prospect Harbor. Lastly, based on road and stream data, it appears that there is a stream crossing located on End Road near Jones Pond that is within the 100-year floodplain. However, this is not a documented crossing within the GIS database.

A 100-year coastal flooding event would also inundate a boat launch in Bunkers Cove and one PDES outfall in Prospect Harbor. However, these two features are inundated during a normal HAT event. No additional infrastructure would be inundated during a 500-year flooding event that isn't already within the 100-year floodplain.

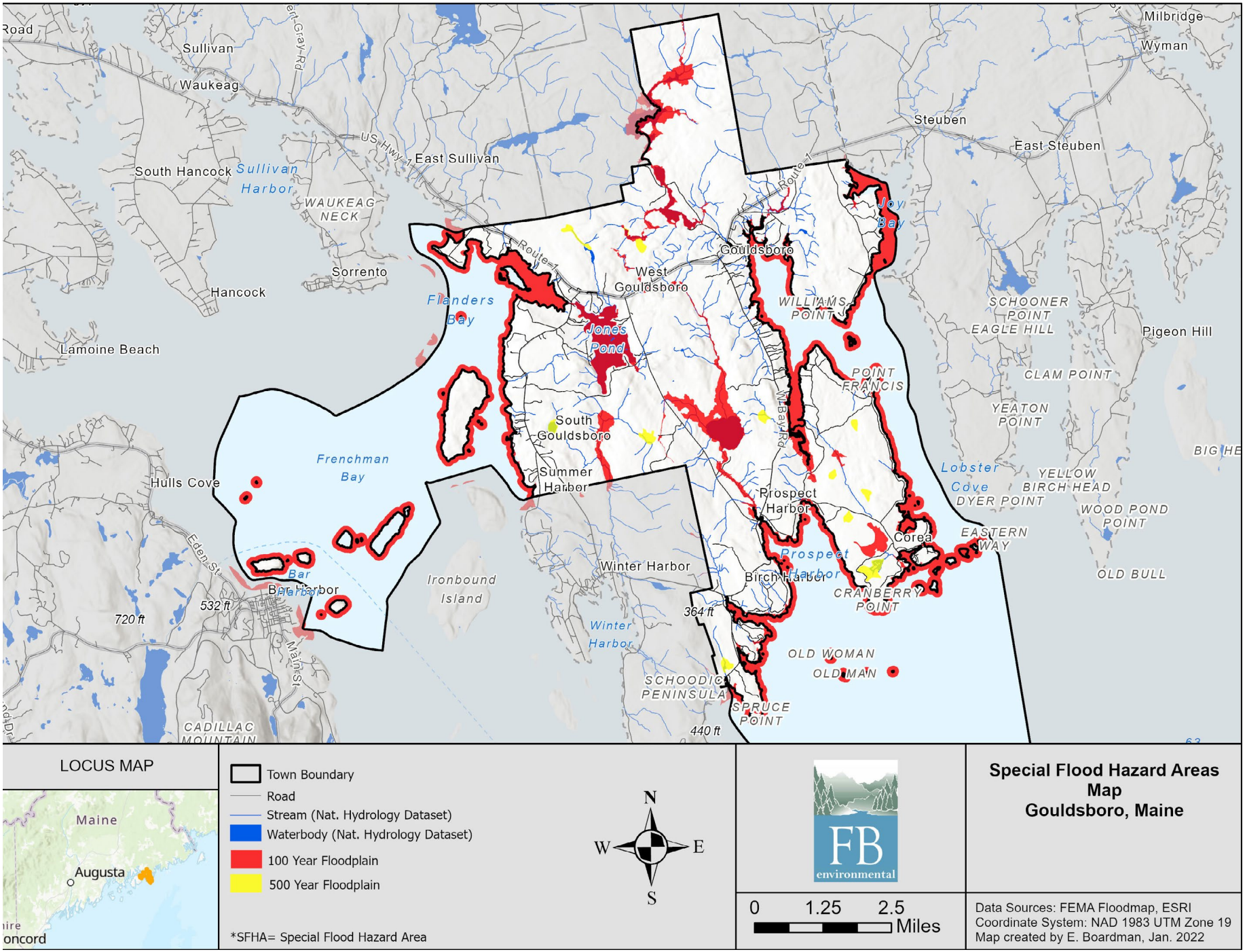


Figure 1: Special flood hazard areas map for Gouldsboro, ME.

SEA LEVEL RISE SCENARIOS

During the HAT+ 1.6 feet SLR scenario, approximately 592 acres of land within the Town would be inundated. This is slightly less than 2% of the Town's land area. One of the largest areas of flooding during this scenario occurs in the wetlands to the south of Grand Marsh Bay (Figure 2). The only infrastructure impacted by the 1.6 feet SLR scenario, that isn't already inundated during the normal HAT, are roads and buildings. The analysis found that one boat launch in Bunkers Cove and a PDES outfall in Prospect Harbor are inundated during normal HAT; therefore, these features are also inundated during the 1.6 feet SLR scenario but to a more severe extent. A total of 17 buildings within the Town would be inundated during the 1.6 feet SLR scenario (Table 2). The densest area of inundated buildings is near Corea Harbor (Figure 3). Approximately 434 linear feet of road is impacted during this SLR scenario (Table 3). The three roads impacted the most are Corea Road, Bunker Pound Road, and Redding Road.

Table 2: Summary of parcels and buildings that are partially or fully inundated during each SLR scenario.

Scenario	Number of Parcels Impacted	Number of Buildings Impacted
HAT+ 1.6 ft	851	17
HAT+ 3.9 ft	899	42
HAT+ 8.8 ft	1,027	179

An additional 2,768 linear feet (0.53 miles) of road is impacted during the HAT+ 3.9 feet SLR scenario, compared to the 1.6 feet scenario. The roads with the greatest additional impact are Francis Pound Road, Grand Marsh Bay Road, and Bunker Pound Road. An additional 25 buildings are inundated during the 3.9 feet SLR scenario. Areas with the most impact to buildings include Corea Harbor, Main Street along Prospect Harbor, and South Gouldsboro.

During the HAT+ 8.8 feet SLR scenario, an additional 15,091 feet (2.9 miles) of road is inundated within the Town. The roads with the greatest additional impact are Corea Road, Crowley Island Road, and Main Street. Grand Marsh Bay and Prospect Harbor converge during this scenario, creating an island out of the portion of Town to the east. An additional 137 buildings are impacted during the 8.8 feet SLR scenario compared to the 3.9 feet scenario. The majority of buildings impacted are in the areas of Corea, Prospect, and Birch harbors. Additionally, 12 cross culverts and one large culvert are inundated during the 8.8 feet scenario. Six of the cross culverts are along Main Street, three are on Corea Road, and two are on West Bay Road along Grand Marsh Bay. The last crossing is designated as a large culvert (i.e., opening greater than five feet and less than 10 feet) and is located on Schoodic Drive, near Wonsqueak Harbor. The American Aquafarms (formerly Maine Fair Trade Lobster) building near Prospect Harbor is inundated during the 8.8 feet SLR scenario. This building is also projected to be inundated in a hurricane scenario of Category 3 or greater (see SLOSH section below).

Table 3: Summary of the highest impacted roads during the three SLR scenarios. Total linear feet of road projected to be inundated is shown for each scenario.

Road	Linear Feet of Road Inundated (approximate)		
SLR Scenario	+1.6ft	+3.9ft	+8.8ft
Corea Rd	105	380	2,154
Crowley Island Rd	-	55	1,332
Main St	-	-	1,148
Grand Marsh Bay Rd	-	532	1,038
Francis Pound Rd	-	560	976
Bunker Pound Rd	174	575	933
Seaswept Way	-	171	916
Schieffelin Point Rd	-	154	908
Peninsula Shore Rd	-	-	874
Lighthouse Point Rd	-	81	864
Redding Rd	155	432	714

HURRICANE SCENARIOS (SLOSH)

The total amount of land area inundated during a Category 4 hurricane is 2,225 acres. This is approximately 7.3% of the Town's land area. Similar to the 8.8 feet SLR scenario, the areas of greatest impact during a Category 4 hurricane are Grand Marsh Bay/Prospect Harbor and Corea Harbor/Gouldsboro Bay. Flood waters nearly connect Grand Marsh Bay to Prospect Harbor during a Category 2 hurricane, with only a small area of land above water. During a Category 3 hurricane the two waterbodies are connected by 3-6 feet of water. During a Category 4 hurricane, the water depth is approximately 6-9 feet deep in the middle of the newly formed channel. Some areas have flood water deeper than 9 feet during this scenario.

Other areas severely impacted in Prospect Harbor include the buildings on Prospect Harbor Point, near the Prospect Harbor Lighthouse, and the American Aquafarms (formerly Maine Fair Trade Lobster) building. The Aquafarms building is inundated by approximately 3-6 feet of water during a Category 4 hurricane. Additionally, the area surrounding Corea Harbor is severely impacted during Category 3 and 4 hurricanes. In addition to the inundation of Crowley Island Road, isolating the Youngs Point area, shoreline buildings such as the Corea Lobster Co-Op, the Catch Your Dinner Lobster Tours building, and Lunch on the Wharf building are inundated by up to 6 feet of water during a Category 3 hurricane.

Table 4. Summary of the amount of land within the Town of Gouldsboro inundated during various hurricane storm categories. The acres and percent of land inundated are not cumulative land area from previous storm categories but represent the amount of additional inland area inundated during each scenario.

Storm Category	Acres of Land Inundated	Total Percent of Town Inundated
1	577	1.9
2	437	1.4
3	531	1.7
4	681	2.2
Total	**2,225**	**7.3**

Why do we have to worry about hurricanes in Maine?

As the Maine Geological Survey explains, "although the threat in Maine is generally small compared with southern New England states, hurricanes can and do happen in Maine. Luckily, Maine sits at the “tail end” of tropical events, and due to our colder Gulf of Maine waters and geographic location, most hurricanes that cross into Maine have made landfall elsewhere and either weakened to tropical storms or become extra-tropical. That said, many of these events have still caused extensive damage, injuries, and even deaths. It is the responsibility of local, regional, and state governments to be prepared for and respond to these events."

Damage in Maine from Hurricane Bob in 1991, the last Category 2 hurricane to make landfall on Maine's coast. © WGME

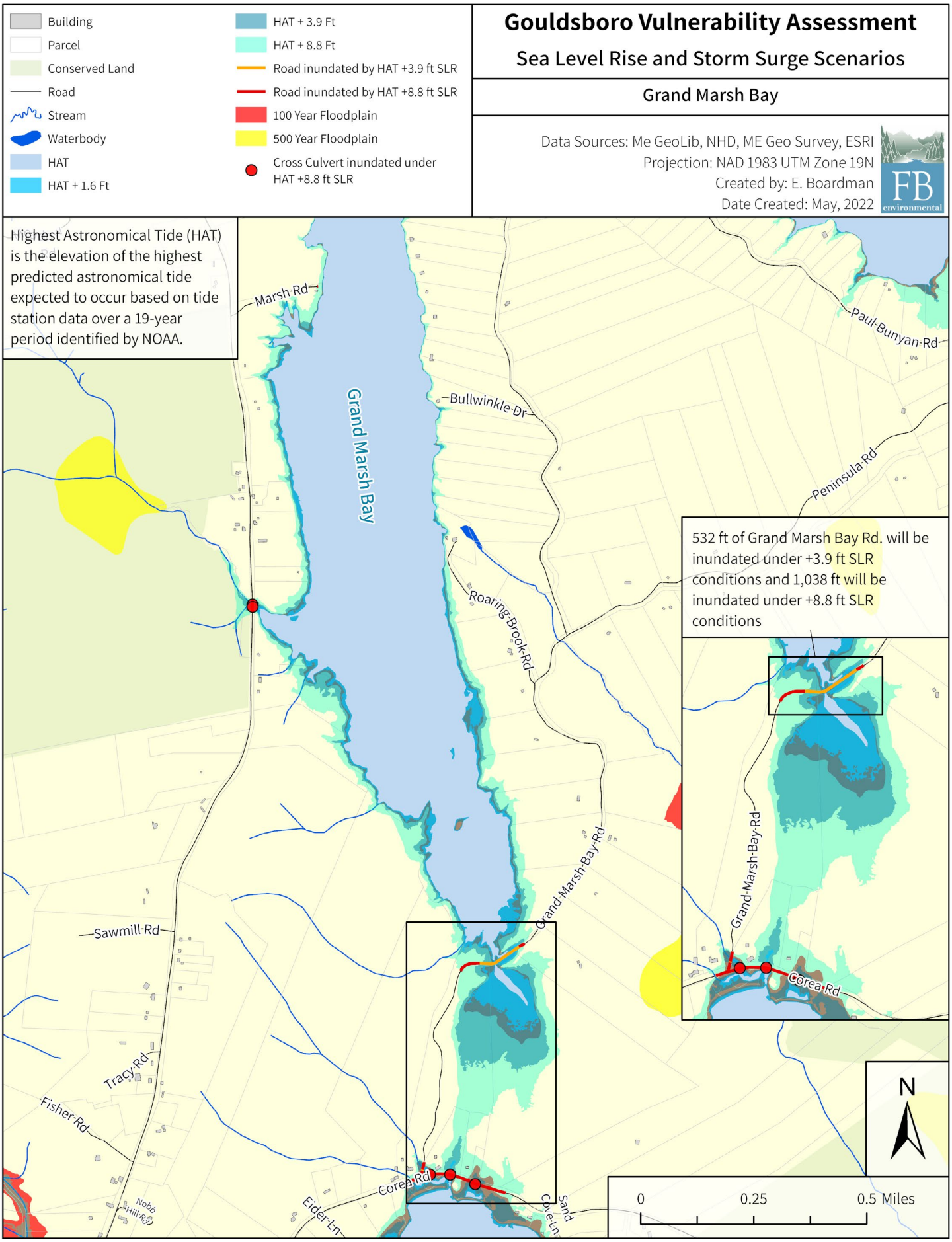


Figure 2: Sea level rise and extreme precipitation event inundation boundaries near Grand Marsh Bay.

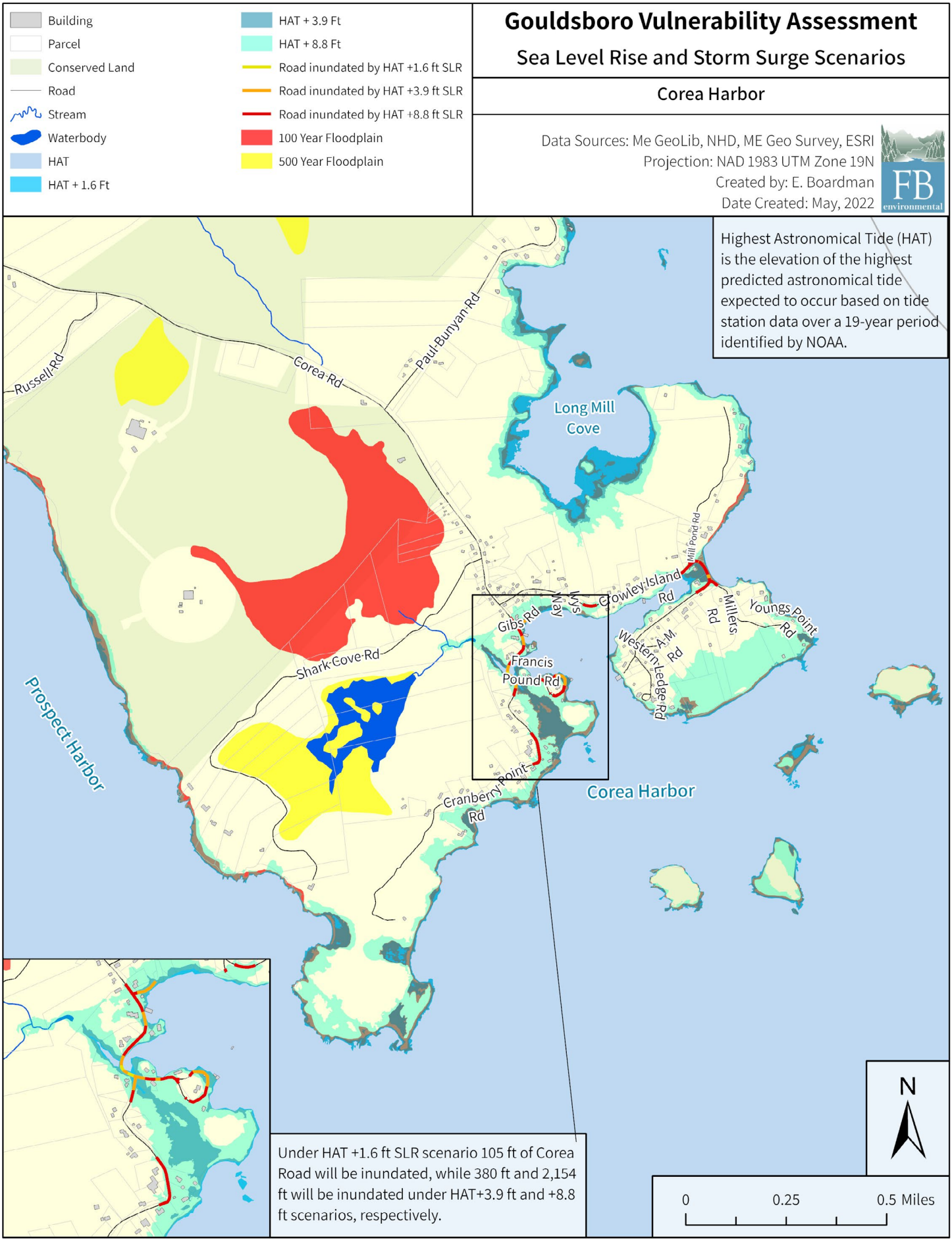


Figure 3: Sea level rise and extreme precipitation event inundation boundaries near Corea Harbor.

DISCUSSION

The vulnerability assessment conducted for the Town has allowed for the identification of vulnerable areas where flooding and critical resources intersect. **One of the Towns greatest vulnerabilities is the flooding of transportation infrastructure.** Flooded roadways can be impassable temporarily until water levels retreat or inaccessible long-term if the road is damaged during the flooding event. Increased water levels and velocities attributed to storm surges, extreme precipitation events, and SLR can cause severe damage to roadways and stream crossings. An example of this is the severe damage to Main Street (Route 186) at the location of a stream crossing in Birch Harbor during a large precipitation event in June 2021 that caused elevated water levels. Temporarily impassable roads can leave communities stranded and unable to access critical resources such as emergency health care, disaster response, law enforcement, and food supplies.

The residential areas around Grand Marsh Bay and Corea Harbor are extremely vulnerable to the flooding of critical transportation infrastructure. During the highest severity SLR scenario evaluated in this study (HAT+ 8.8 feet) and during hurricane events greater than Category 1, Grand Marsh Bay Road and Corea Road are inundated, isolating the communities located to the east of Grand Marsh Bay, including Corea Harbor. In these scenarios the entirety of Corea Harbor would be cut off from emergency services. According to The Nature Conservancy's Coastal Risk Explorer (2022), 1,211 addresses would be isolated with 6 feet of SLR. In addition, sections of Corea Road, Francis Pound Road, and Cranberry Point Road are flooded during the 8.8 feet SLR scenario, further blocking residences at the southern end of Cranberry Point Road. Similarly, Crowley Island Road is inundated near Sand Cove during the 3.9 feet and 8.8 feet SLR scenarios, blocking resources from the residences at the southern end of Crowley Island Road and Youngs Point Road. In addition to transportation infrastructure vulnerabilities, developed parcels and buildings in areas projected to be inundated will be faced with structural damage to buildings and septic system infrastructure. Septic systems flooded temporarily during storm surges or repeatedly during SLR and groundwater rise are at risk of malfunctioning or failing, causing costly repairs and polluting local water resources such as shellfishing areas.

In contrast to areas in the Town that are low-lying and will experience large areas of inundation during flooding events and SLR scenarios, some coastal areas showed little impact in the vulnerability assessment. The shoreline of South Gouldsboro and the shoreline of Jones Cove show minimal area of inundation during even the most severe SLR scenarios (see maps on Pages 28 and 29). This is likely due to large vertical relief in these areas, making these shorelines resilient to inundation in the face of rising sea levels. However, this also means that this area is likely vulnerable to bluff erosion. Wave action and the resulting extreme forces exerted on the shoreline during storm surge and hurricane events can cause severe erosion of the shoreline. Bluffs, or steep shorelines formed in sediment and elevating three feet or more above the high tide line, can be very susceptible to erosion, especially if they are less vegetated and are composed of sand or gravel sediments (MGS, 2006).

View of the area of Crowley Island Road that is vulnerable to inundation during SLR and storm surge scenarios, resulting in the isolation of numerous residences from emergency services. © Town of Gouldsboro

While infrastructure in these areas is not currently at risk to inundation according to the models evaluated in this study, these areas are at a high risk of coastal erosion and shoreline bank failure.

Gouldsboro faces many of the same coastal hazards as other Maine towns, except for those southern Maine towns with large sandy beaches and extensive estuary systems. **Gouldsboro experiences strong storm surges and associated flooding from large storm events such as Nor'easters in conjunction with tidal cycles or events. Rocky shoreline bluffs along the western shores of Gouldsboro face erosion from intensified storm surges and wave action, while low-lying salt marshes along the southeastern shores of Gouldsboro face inundation from sea level rise that will continue to impact infrastructure.** For example, the tidal wetland complex in Grand Marsh Bay is projected to experience inundation at levels that will restrict access across Grand Marsh Bay Road. Data on potential tidal marsh migration is available from the Maine Natural Areas Program (MNAP); however, evaluating this data was not part of the scope of this project. Tidal marsh migration is a key component of a community's flood risk and should be considered when making management decisions related to flood risk and adaptation. Tidal marshes and freshwater wetland systems are key natural features to accommodate floodwaters because the inundation or loss of these features due to SLR will exacerbate flooding. Where tidal marshes cannot migrate inland due to development, they will disappear. The wealth of habitat provided by wetlands may also be compromised by future flooding increases. Habitat and species loss will likely be greatest in areas where marsh systems cannot retreat or migrate inland. High water levels can drown salt marshes, which in turn converts salt marshes into mudflats and mudflats into subtidal zones. Storm surges can also cause sedimentation in habitat that lies behind beaches, smothering shellfish beds. Saltwater intrusion into freshwater wetlands can affect habitat that was formerly freshwater turned brackish. Altered coastal habitats can affect the timing of nesting and migration for seabirds.

Gouldsboro, like all communities, will face flooding due to increased precipitation and storm frequency. **As a coastal community, Gouldsboro faces the risk of heavy precipitation events coinciding with high tides, exacerbating flood risks.** Coastal communities in Maine are being forced to evaluate their existing infrastructure and land use planning regulations and adapt them to mitigate the impacts of future conditions. Many communities are investing in the development of action plans to help guide them towards becoming more resilient to coastal hazards.

Gouldsboro shore in Prospect Harbor © Town of Gouldsboro

Bridge washout in 2021 in nearby Town of Birch Harbor from a different viewpoint as on Page 12. © Natasha Foutch/Ellsworth American.

South Gouldsboro. © Bill Zoellick

Iconic sight at the former Maine Fair Trade Lobsterman in Prospect Harbor. © M. Kelly

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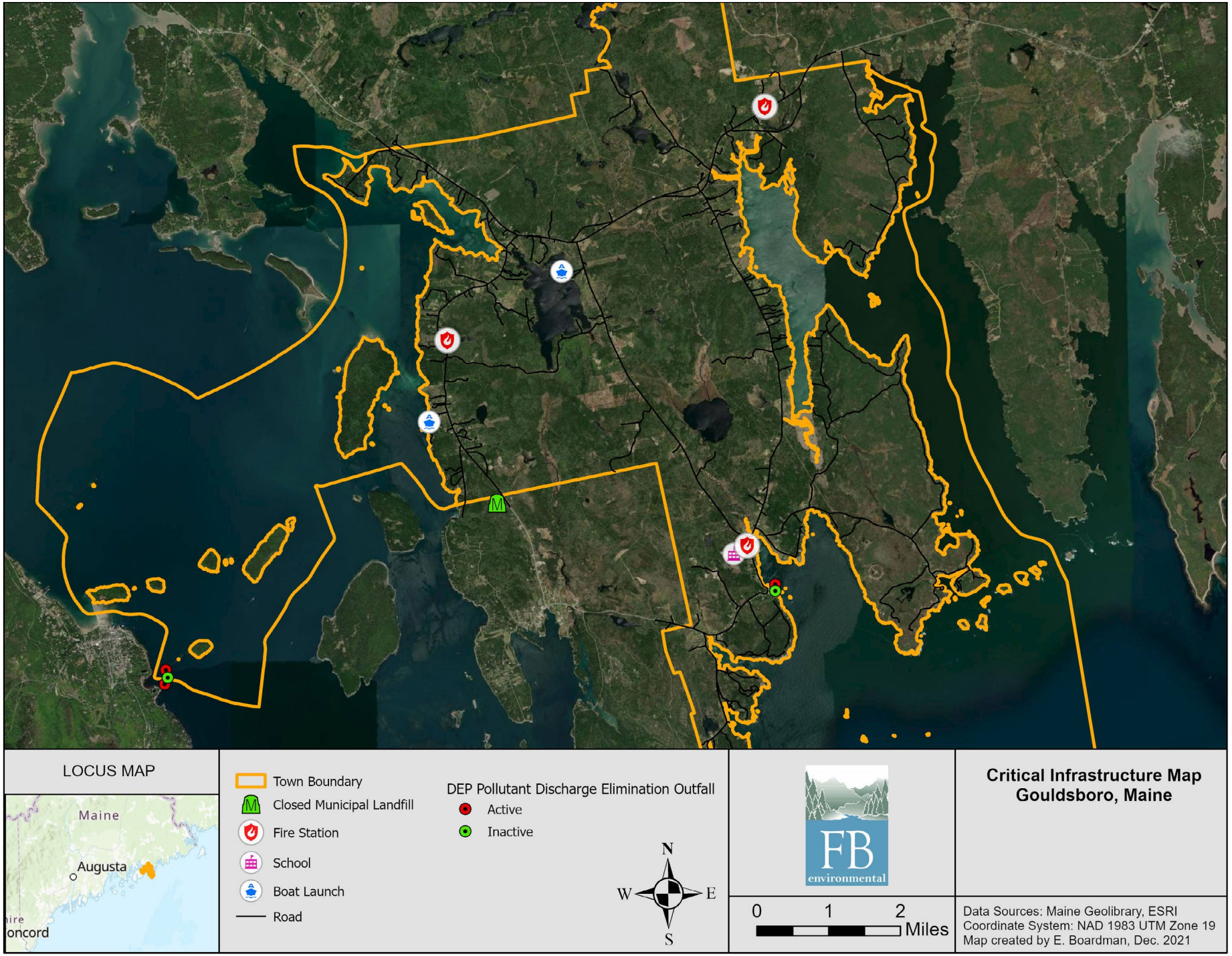
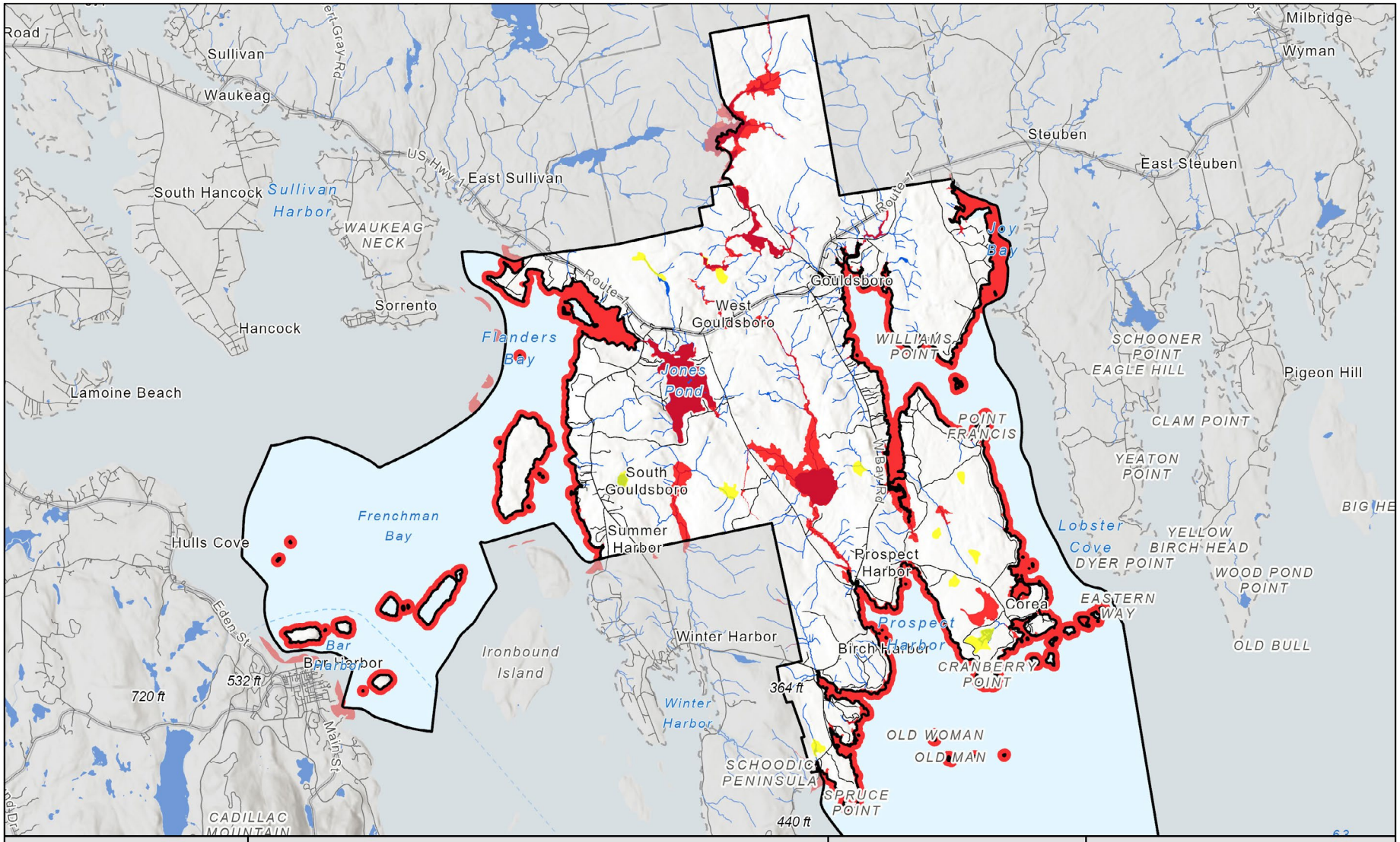
APPENDIX A: MAPS


LOCUS MAP
Maine
Augusta
Concord
Town Boundary
Closed Municipal Landfill
Fire Station
School
Boat Launch
Road
DEP Pollutant Discharge Elimination Outfall
Active
Inactive
N
W
E
S
FB environmental
0 1 2 Miles
Critical Infrastructure Map
Gouldsboro, Maine
Data Sources: Maine Geolibrary, ESRI
Coordinate System: NAD 1983 UTM Zone 19
Map created by E. Boardman, Dec. 2021



LOCUS MAP

- Town Boundary
- Road
- Stream (Nat. Hydrology Dataset)
- Waterbody (Nat. Hydrology Dataset)
- 100 Year Floodplain
- 500 Year Floodplain

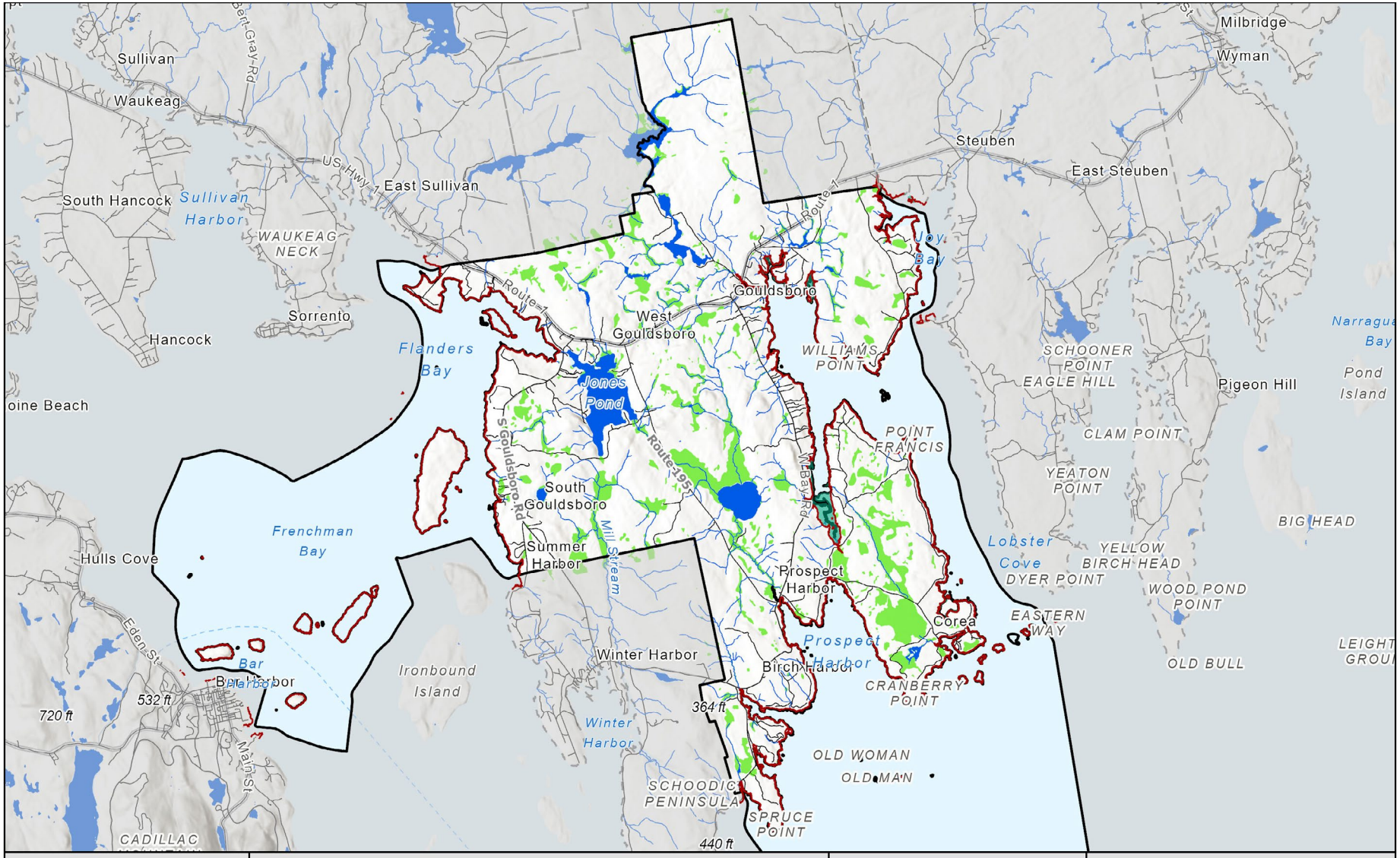
*SFHA= Special Flood Hazard Area

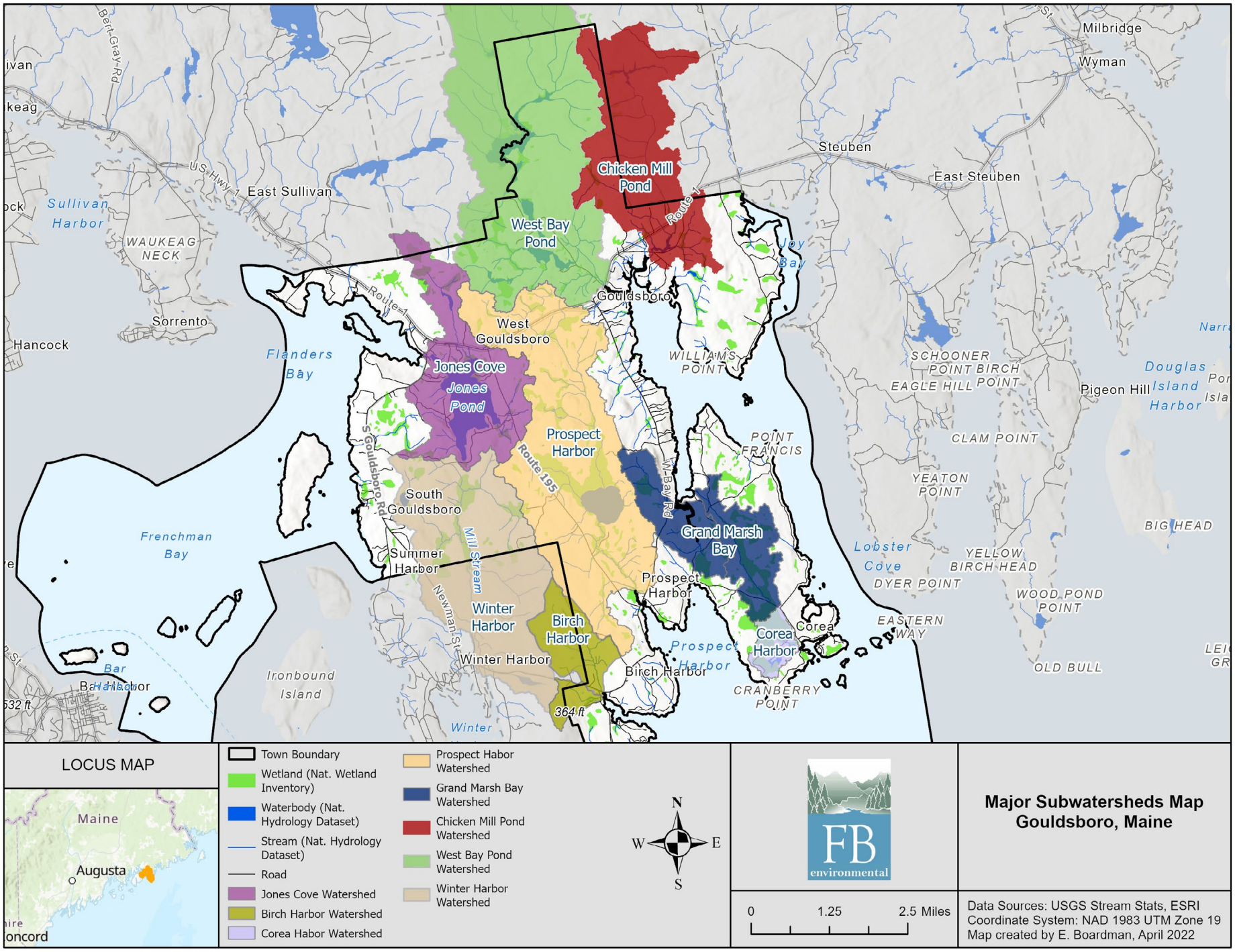
N W E S

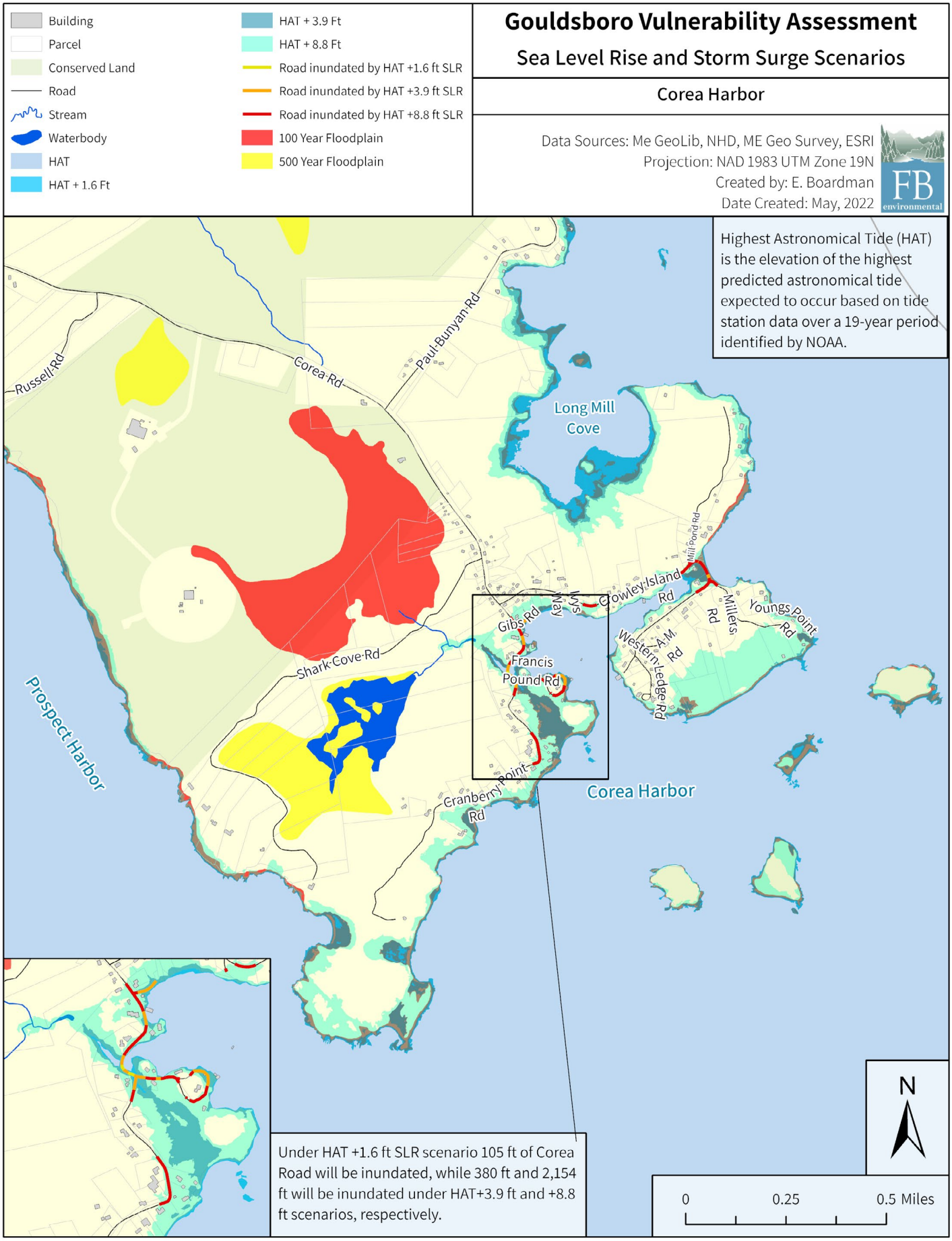
0 1.25 2.5 Miles

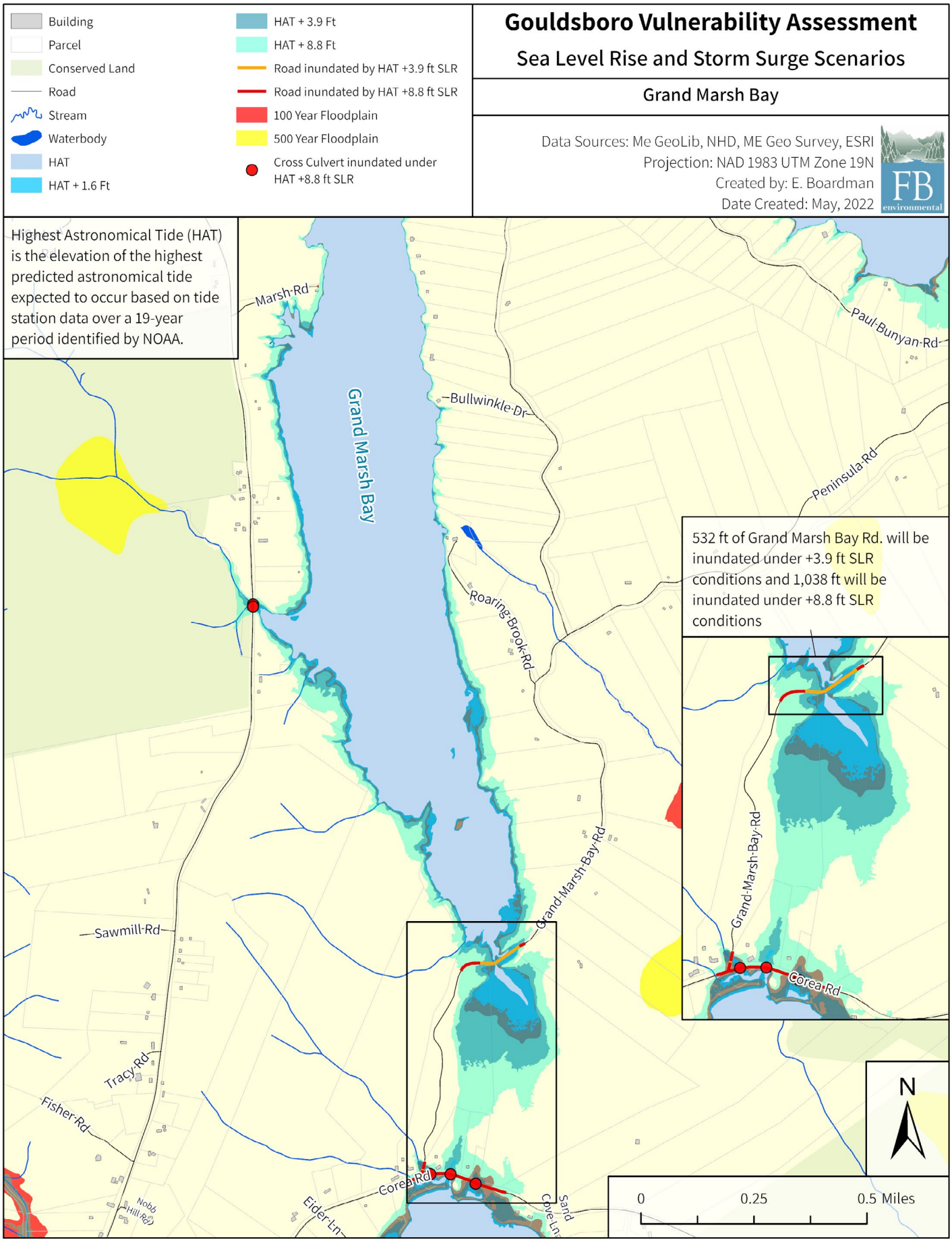
Special Flood Hazard Areas Map
Gouldsboro, Maine

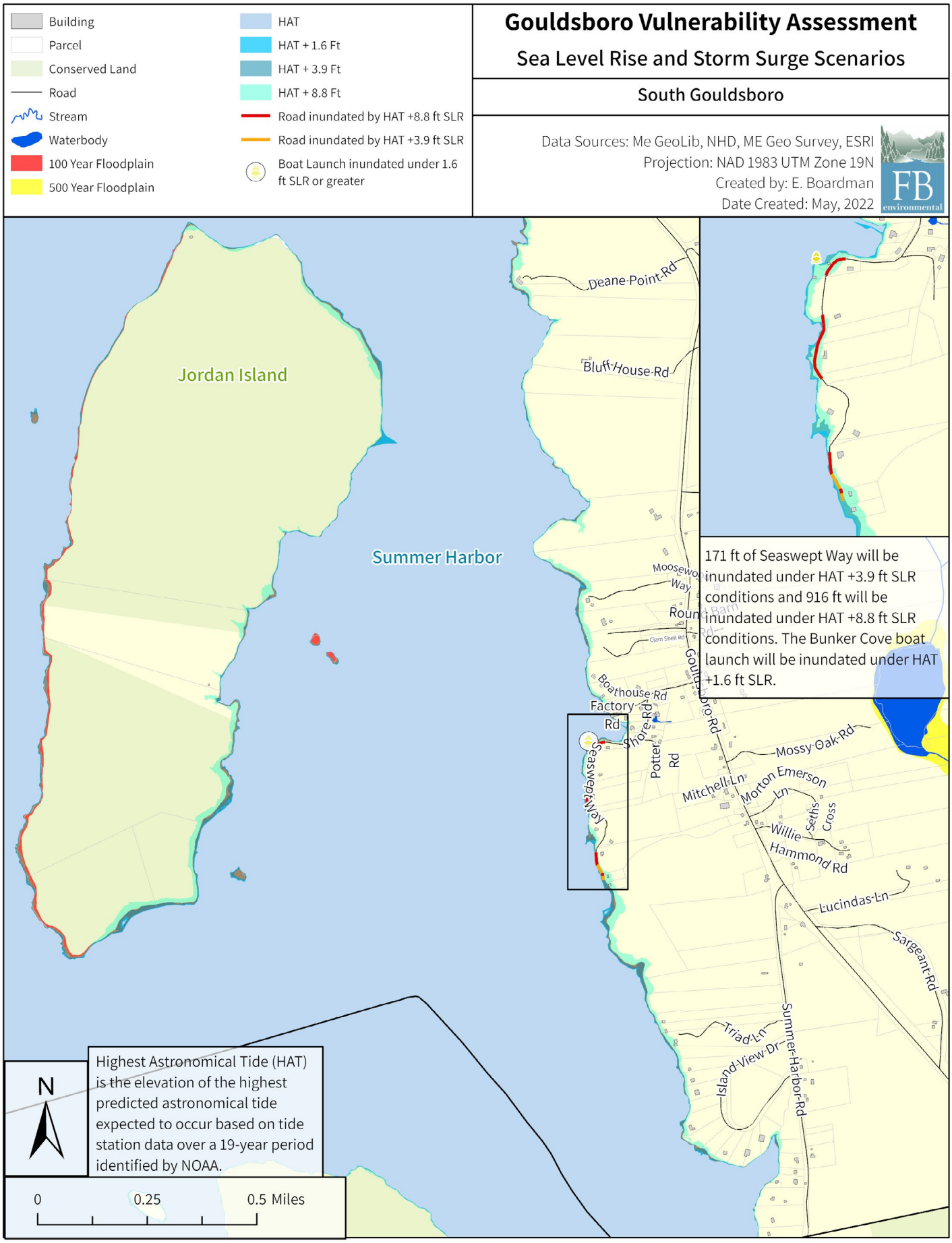
Data Sources: FEMA Floodmap, ESRI
Coordinate System: NAD 1983 UTM Zone 19
Map created by E. Boardman, Jan. 2022

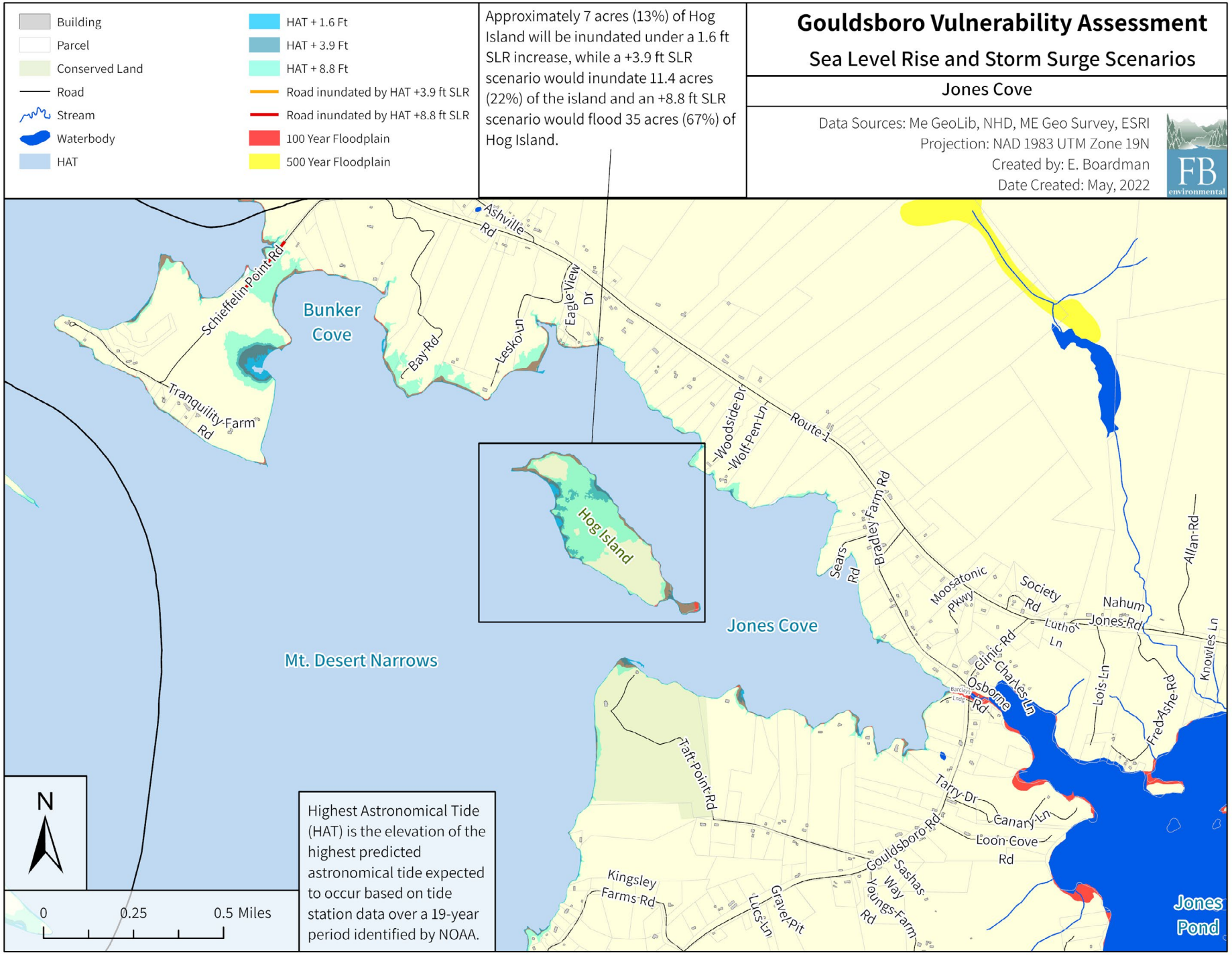

Milbridge
Wyman
Sullivan
Waukeag
Steuben
East Steuben
US Hwy 1
East Sullivan
South Hancock
Sullivan Harbor
WAUKEAG NECK
Route 1
Joy Bay
Gouldsboro
West Gouldsboro
Sorrento
Hancock
Flanders Bay
WILLIAMS POINT
SCHOONER POINT
EAGLE HILL
Pigeon Hill
Narragua Bay
Pond Island
Jones Pond
POINT FRANCIS
CLAM POINT
YEATON POINT
Route 195
S Gouldsboro Rd
South Gouldsboro
Mill Stream
Mt Bar Rd
BIG HEAD
Frenchman Bay
Summer Harbor
Lobster Cove
YELLOW BIRCH HEAD
DYER POINT
Hulls Cove
Prospect Harbor
WOOD POND POINT
EASTERN WAY
Corea
Eden St
Bar Harbor
Ironbound Island
Winter Harbor
Prospect Harbor
Birch Harbor
OLD BULL
CRANBERRY POINT
532 ft
720 ft
364 ft
Winter Harbor
OLD WOMAN
OLD MAN
Main St
SCHOODIC PENINSULA
SPRUCE POINT
CADILLAC
440 ft
LOCUS MAP
Maine
Augusta
Town Boundary
Waterbody (Nat. Hydrology Dataset)
Wetland (Nat. Wetland Inventory)
Tidal Marsh / Estuary
Stream (Nat. Hydrology Dataset)
Highest Astronomical Tide
Road
N
W
E
S
FB environmental
0 1.25 2.5
Miles
Hydrologic Resources Map
Gouldsboro, Maine
Data Sources: Maine Geolibrary, ESRI
Coordinate System: NAD 1983 UTM Zone 19
Map created by E. Boardman, Dec. 2021


Milbridge
Wyman
Steuben
East Steuben
Chicken Mill Pond
West Bay Pond
East Sullivan
Sullivan Harbor
WAUKEAG NECK
Sorrento
Hancock
Flanders Bay
Gouldsboro
West Gouldsboro
Jones Cove
Jones Pond
Prospect Harbor
South Gouldsboro
Summer Harbor
Frenchman Bay
Mill Stream
Newman Stream
Winter Harbor
Birch Harbor
Corea Harbor
Corea
Ironbound Island
Bar Harbor
364 ft
532 ft
WILLIAMS POINT
SCHOONER POINT
BIRCH EAGLE HILL POINT
Pigeon Hill
Douglas Island Harbor
POINT FRANCIS
CLAM POINT
YEATON POINT
Grand Marsh Bay
Lobster Cove
YELLOW BIRCH HEAD
DYER POINT
WOOD POND POINT
EASTERN WAY
OLD BULL
CRANBERRY POINT
BIG HEAD
Route 1
Route 195
S Gouldsboro Rd
W Bay Rd
LOCUS MAP
Maine
Augusta
Town Boundary
Wetland (Nat. Wetland Inventory)
Waterbody (Nat. Hydrology Dataset)
Stream (Nat. Hydrology Dataset)
Road
Jones Cove Watershed
Birch Harbor Watershed
Corea Habor Watershed
Prospect Habor Watershed
Grand Marsh Bay Watershed
Chicken Mill Pond Watershed
West Bay Pond Watershed
Winter Harbor Watershed
N
W
E
S
FB environmental
0
1.25
2.5 Miles
Major Subwatersheds Map
Gouldsboro, Maine
Data Sources: USGS Stream Stats, ESRI
Coordinate System: NAD 1983 UTM Zone 19
Map created by E. Boardman, April 2022


Building
Parcel
Conserved Land
Road
Stream
Waterbody
HAT
HAT + 1.6 Ft
HAT + 3.9 Ft
HAT + 8.8 Ft
Road inundated by HAT +1.6 ft SLR
Road inundated by HAT +3.9 ft SLR
Road inundated by HAT +8.8 ft SLR
100 Year Floodplain
500 Year Floodplain
Gouldsboro Vulnerability Assessment
Sea Level Rise and Storm Surge Scenarios
Corea Harbor
Data Sources: Me GeoLib, NHD, ME Geo Survey, ESRI
Projection: NAD 1983 UTM Zone 19N
Created by: E. Boardman
Date Created: May, 2022
FB environmental
Highest Astronomical Tide (HAT) is the elevation of the highest predicted astronomical tide expected to occur based on tide station data over a 19-year period identified by NOAA.
Russell Rd
Corea Rd
Paul Bunyan Rd
Long Mill Cove
Mill Pond Rd
Crowley Island Rd
Ivys Way
Gibs Rd
Millers Rd
Youngs Point Rd
Western Ledge Rd
A M Rd
Francis Pound Rd
Shark Cove Rd
Prospect Harbor
Corea Harbor
Cranberry Point Rd
Under HAT +1.6 ft SLR scenario 105 ft of Corea Road will be inundated, while 380 ft and 2,154 ft will be inundated under HAT+3.9 ft and +8.8 ft scenarios, respectively.
N
0
0.25
0.5 Miles


Building
Parcel
Conserved Land
Road
Stream
Waterbody
HAT
HAT + 1.6 Ft
HAT + 3.9 Ft
HAT + 8.8 Ft
Road inundated by HAT +3.9 ft SLR
Road inundated by HAT +8.8 ft SLR
100 Year Floodplain
500 Year Floodplain
Cross Culvert inundated under HAT +8.8 ft SLR
Gouldsboro Vulnerability Assessment
Sea Level Rise and Storm Surge Scenarios
Grand Marsh Bay
Data Sources: Me GeoLib, NHD, ME Geo Survey, ESRI
Projection: NAD 1983 UTM Zone 19N
Created by: E. Boardman
Date Created: May, 2022
FB environmental
Highest Astronomical Tide (HAT) is the elevation of the highest predicted astronomical tide expected to occur based on tide station data over a 19-year period identified by NOAA.
532 ft of Grand Marsh Bay Rd. will be inundated under +3.9 ft SLR conditions and 1,038 ft will be inundated under +8.8 ft SLR conditions
Marsh Rd
Grand Marsh Bay
Bullwinkle Dr
Paul Bunyan Rd
Peninsula Rd
Roaring Brook Rd
Grand Marsh Bay Rd
Sawmill Rd
Tracy Rd
Fisher Rd
Nobb Hill Rd
Corea Rd
Elder Ln
Sand Cove Ln
N
0
0.25
0.5 Miles


Building
Parcel
Conserved Land
Road
Stream
Waterbody
100 Year Floodplain
500 Year Floodplain
HAT
HAT + 1.6 Ft
HAT + 3.9 Ft
HAT + 8.8 Ft
Road inundated by HAT +8.8 ft SLR
Road inundated by HAT +3.9 ft SLR
Boat Launch inundated under 1.6 ft SLR or greater
Gouldsboro Vulnerability Assessment
Sea Level Rise and Storm Surge Scenarios
South Gouldsboro
Data Sources: Me GeoLib, NHD, ME Geo Survey, ESRI
Projection: NAD 1983 UTM Zone 19N
Created by: E. Boardman
Date Created: May, 2022
FB environmental
Jordan Island
Summer Harbor
Deane Point Rd
Bluff House Rd
Moosewood Way
Round Barn Rd
Clam Shell Art
Goldsboro Rd
Boathouse Rd
Factory Rd
Shore Rd
Potter Rd
Seaswept Way
Mossy Oak Rd
Mitchell Ln
Morton Emerson Ln
Seths Cross
Willie Hammond Rd
Lucindas Ln
Sargeant Rd
Triad Ln
Island View Dr
Summer Harbor Rd
171 ft of Seaswept Way will be inundated under HAT +3.9 ft SLR conditions and 916 ft will be inundated under HAT +8.8 ft SLR conditions. The Bunker Cove boat launch will be inundated under HAT +1.6 ft SLR.
N
Highest Astronomical Tide (HAT) is the elevation of the highest predicted astronomical tide expected to occur based on tide station data over a 19-year period identified by NOAA.
0
0.25
0.5 Miles


Building
Parcel
Conserved Land
Road
Stream
Waterbody
HAT
HAT + 1.6 Ft
HAT + 3.9 Ft
HAT + 8.8 Ft
Road inundated by HAT +3.9 ft SLR
Road inundated by HAT +8.8 ft SLR
100 Year Floodplain
500 Year Floodplain
Approximately 7 acres (13%) of Hog Island will be inundated under a 1.6 ft SLR increase, while a +3.9 ft SLR scenario would inundate 11.4 acres (22%) of the island and an +8.8 ft SLR scenario would flood 35 acres (67%) of Hog Island.
Gouldsboro Vulnerability Assessment
Sea Level Rise and Storm Surge Scenarios
Jones Cove
Data Sources: Me GeoLib, NHD, ME Geo Survey, ESRI
Projection: NAD 1983 UTM Zone 19N
Created by: E. Boardman
Date Created: May, 2022
FB environmental
Bunker Cove
Mt. Desert Narrows
Jones Cove
Hog Island
Jones Pond
Ashville Rd
Schieffelin Point Rd
Tranquility Farm Rd
Bay Rd
Lesko Ln
Eagle View Dr
Woodside Dr
Wolf Pen Ln
Route 1
Bradley Farm Rd
Sears Rd
Moosatonic Pkwy
Society Rd
Nahum Jones Rd
Luthor Ln
Allan Rd
Knowles Ln
Clinic Rd
Osborne Rd
Charles Ln
Lois Ln
Fred Ashe Rd
Taft Point Rd
Tarry Dr
Canary Ln
Loon Cove Rd
Gouldsboro Rd
Sashas Way
Youngs Farm Rd
Gravel Pit
Lucs Ln
Kingsley Farms Rd
N
0
0.25
0.5 Miles
Highest Astronomical Tide (HAT) is the elevation of the highest predicted astronomical tide expected to occur based on tide station data over a 19-year period identified by NOAA.