CLIMATE ADAPTATION PLAN

Vinalhaven, Maine Wastewater System

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VINALHAVEN, MAINE
MAY 2019

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1. INTRODUCTION

In 2018, Vinalhaven, Maine, applied for a $20,000 grant from DEP to prepare a Climate Adaptation Plan (CAP) for its wastewater system. Maine DEP offers municipalities this grant opportunity as an incentive to think about and plan for mitigation or adaptation measures that may be needed to help wastewater systems remain resilient under changing climate conditions.

The Island of Vinalhaven worked closely to complete the following tasks for the CAP:

- Identify natural hazards associated with climate change,
- Evaluate impacts that these natural hazards may have on the wastewater system and its components, and
- Determine mitigation or adaptation options for improving the overall resiliency of the wastewater system.

For the purpose of completing the CAP, the wastewater system means all of the island's infrastructure to collect, convey, treat municipal sewage and discharge treated effluent. The overall goal of the planning effort was to assess the wastewater system's vulnerability to climate change and then develop a plan for resiliency.

1.1 Community Overview

Located approximately 13 miles off the coast of Rockland, Maine, Vinalhaven is the largest island (over 14,000 acres) in Penobscot Bay. Carver's Harbor is the major port serving the island which is home to over 200 lobster boats, a MDOT ferry service, a downtown area and commercial businesses mostly associated with fishing, year round residents and tourism. The community has an economic impact on the entire State of Maine because it is one of the top lobster landing ports.

This island community has a year round population of 1,140 (US Census 2017) that swells to approximately 4,700 during the summer. Over 80% of the year round population live in the Vinalhaven Village area, which is located on the south side of the island which is where a majority of the commercial and maritime activities, occur.

Commented [MM1]: Where did you get this number? This resource http://www.islandinstitute.org/places/vinalhaven says 2,200

Commented [MK2R1]: That is from the O&M Manual. I would suggest we ask the Town if that is still accurate.

Commented [MM3R1]: Gabe or Andy – can you please confirm this number and a data source we can cite? Thank you!

1.2 Climate Adaptation Plan Process

With the intent of assessing the wastewater treatment system's vulnerabilities to climate change and then develop a plan for system resiliency, Vinalhaven engaged Woodard & Curran to help guide the community through the process. The primary participants for the project included:

- Andrew Dorr, Town Manager
- Kevin Carney, Wastewater Treatment Facility Operator, Maine Water
- Peter Farrelly, Water System Operator, Maine Water
- Mike Cummons, Maine Water
- Vinalhaven Sea Level Rise Committee

These stakeholders considered and shared information about how the wastewater system has been impacted in the past by various severe weather events, what components of the system are vulnerable to changing climate conditions and where changes can be made for better operation and increased resiliency.

As required by the Maine Department of Environmental Protection, the Maine Emergency Management Agency (MEMA) was contacted in May 2019 to inform them that Vinalhaven has prepared a CAP for the wastewater system.

1.3 Wastewater Background Information

The waters around the island, including those in proximity to the village, contain shell fishing areas and support the lobster industry, the local economy's most important industry. Prior to the installation of the sewer system, some shell fishing areas had been seasonally closed down as a result of pollution from sewage discharges from the village area. Although it was an important part of the island's economy in the 1800's, the granite that forms the island did not provide suitable soils for the disposal of wastewater. In the village area, there was insufficient land area to compensate for these poor soils, and many homes and businesses were faced with inadequate or failing subsurface sewage treatment systems. In the past many properties opted for overboard discharges into the surrounding surface waters, often without disinfection. These environmental concerns along with a need for a reliable system for disposal of wastewater drove the Town to investigate and ultimately install a conventional sewer collection system and wastewater treatment facility (WWTF).

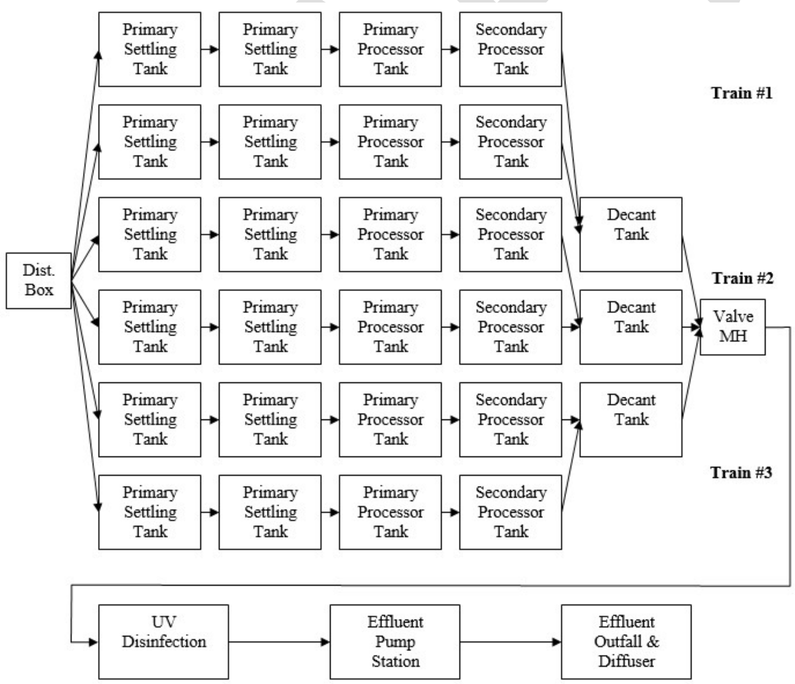
Planning for the WWTF and sewer collection system began in the late 1990's with the Facilities Plan and Design Basis Report being completed in 2001. Construction of the WWTF and collection system was completed in Summer of 2004 with much of the village area's approximately 400 users connecting to the system in the following years. The WWTF is located just inland from Sand Cove at 62 Sands Road and is approximately one tenth of a mile from the Maine State ferry terminal. As previously stated, the wastewater collection system is located primarily in the village area of Town. The system consists of approximately 3.7 miles of gravity sewer mains, 1.5 miles of force main, and 0.4 miles of pressure sewer. In addition to the linear infrastructure, the collection system also has 9 pump stations all designed with submersible pumps and above grade controls and electrical panels. **Figure 1 in Appendix A** shows an overview of the wastewater system in the Town.

The wastewater system is surrounded by small commercial and residential lots where buildings are close together. Because of the configuration of Carver's Harbor, Carver's Pond, Sands Cove, and Indian Creek, a large number of these village lots have water frontage while the rest of the island is rural, undeveloped, and unsewered.

2. VINALHAVEN WASTEWATER SYSTEM

The Vinalhaven WWTF is a municipally owned facility consisting of primary and secondary treatment and a disinfection system. Although the system is owned by the Town of Vinalhaven, Maine Water, a contract operations company, operates and maintains the system. Maine Water has been working with the Town and operating the system since the startup of the system in 2004. All WWTF unit processes are housed at the Sands Road facility. The sewer collection system and pump stations convey municipal wastewater generated in the village area of Town, located at the southern tip of the island, to the WWTF. Wastewater enters the facility from the collection system from the influent valve manhole which combines flow from a 4-inch force main originating at the Sands Road Pump Station and a 6-inch force main originating at the West Main Street Pump Station into a 6-inch force main. The flow is then split in the distribution box to the three treatment trains. The WWTF is designed to handle an average daily flow of 72,000 gallons. In 2017, the system treated 7.18 million gallons of wastewater, an average daily flow of 19,673 gallons per day. The average daily flow in 2016 was 19, 816 gallons per day. Current operation from June to September uses two treatment trains and four process lines for up to 48,000 gpd. October to May continues to operate two treatment trains and four process lines but with limited flows only up to 36,000 gpd. As a result, there is always excess capacity available. The facility is not hydraulically limited at this time and has capacity for a substantial number of future users to connect to the system. **Figure 2-1** presents a diagram of the treatment process.

Figure 2-1: Treatment System Block Flow Diagram



Source: *O&M Manual for Wastewater System*

2.1 Wastewater Treatment Facility Location

The WWTF site consists of two main areas, the area around the control building and the area around the treatment tanks. The 30-ft square control building is located approximately 20 ft from the edge of Sands RD. The control building is a custom built structure used to house the UV disinfection system, laboratory and the electrical and controls equipment for the WWTF. The building's concrete foundation extends 1-ft above the finish floor elevation to 20.37 feet above sea level (FASL); the finish floor elevation of the building Is 19.37 FASL at the perimeter of the building with a low point of 18.93 FASL at the floor drains in the center of the building. Water collected by the floor drains enters the control building sump pump pit to be pumped to treatment tankage for treatment. The remainder of the building is a wooden structure with vinyl siding and a pitched roof. A double door allows access to the control building on the west side of the building.

Photo: Wastewater Treatment Facility Control Building

The area around the control building is relatively flat with ground elevations on the south side of the building being approximately 18 FASL and 24 FASL on the north side of the building. Within the building most critical equipment is elevated approximately 6 inches above the floor including electrical and control panels, sampling equipment, air compressor, etc. Outside the north side of the building sits the permanent emergency diesel generator. The generator is located on a flush with grade concrete equipment pad with a top elevation of approximately 23 FASL. Adjacent to the generator are 4 above grade propane cylinders used as fuel supply for the control building unit heaters. Power and communications lines to the control building are located underground with critical service entrance infrastructure inside the building. The east and south sides of the control building have limited means of access and have become overgrown with vegetation. The facility's driveway and lawn are located on the west side of the control building and are primarily at level ground.

The treatment tankage area is located on the same site as the control building although significantly elevated from the area of the control building. A set of steps from the control building rises in elevation approximately 20 ft to access the treatment tankage. The treatment tankage is at an elevation of approximately 36 FASL. Vehicle access to the tankage area is provided by a dirt road from the WWTF semicircular driveway to the head end of the treatment system on the west side of the site. This is the access path used by the sludge tanker truck when sludge must be removed from the system.

Photo: Wastewater Treatment Tankage Area

2.2 Primary Treatment

Pretreatment consists of removal of rags, debris, floating material, and dense solids typically referred to as "grit". These contaminants can clog equipment and the filtration media used in the biological treatment processes. Both pretreatment and primary treatment occur in the primary settling tanks at the facility.

The primary treatment settling tanks provide a "quiet" zone to allow material to settle out of the liquid flow. The settled solids are allowed to accumulate in the tanks, where they are anaerobically digested by the bacteria that grow within the sludge blanket. Accumulated sludge is occasionally pumped from the primary settling tanks and transported off the island and disposed of.

There are three trains consisting of two columns of two for a total of twelve 8,000 gallon primary settling tanks. Each train is capable of being taken offline by inserting a mechanical plug in the appropriate effluent line of the distribution box.

2.3 Secondary Treatment

Secondary treatment consists of a packaged recirculating biological trickling filter system by SeptiTech, Inc. The wastewater enters at the bottom of the processor tanks below the filter media and is pumped up using recirculation pumps and evenly sprayed over the top of the media to create the trickling effect. Biological treatment occurs in the mixed-liquor as it passes through the media. Sludge and floc accumulated from the dead microbes as a result of the treatment process is pumped back from the processor tanks to the distribution box to undergo further anaerobic digestion.

There are three trains consisting of two columns of one primary processor and one secondary processor for a total of twelve 8,000 gallon biological treatment tanks. Each train is capable of being taken offline by inserting a mechanical plug in the appropriate effluent line of the distribution box. The pump back pumps are only located in the second chamber of the secondary processors, not in the primary processors. Effluent is moved along the processors and to the decant tanks by discharge pumps.

2.4 Effluent Decant System

Effluent from the secondary system is pumped to the decant tanks where any leftover microbes are pumped back to the distribution box to start the treatment from the beginning. Each train has one decant tank for a total of three 8,000 gallon tanks. Effluent is pumped from the decant tanks to the effluent valve manhole. The valves in the manhole can be throttled to provide acceptable flow for the UV disinfection system.

2.5 UV Disinfection System

During the design process for the WWTF, the Town expressed opposition to the use of chlorine or other chemical oxidants for disinfection. One of the main reasons for this opposition was the formation of oxidation by-products and its potential effect on the lobster storage and handling facilities located in Carvers Harbor. As a result, a UV disinfection system was installed during the initial construction of the WWTF to disinfect the effluent prior to discharge. UV irradiation achieves disinfection by inducing photobiochemical changes within microorganisms. One of the principle advantages of UV disinfection is that it does not create disinfection by-products. UV disinfection is considered a safe and effective means of protecting the lobster storage and handling facilities in Carver's Harbor.

The system, which is housed in the control building, consists of a stainless steel trough with two banks of two lamp modules, each with six bulbs. The process is designed to handle 270 gpm. The effluent passes through an inline magnetic flow meter before existing the building via an 8-inch gravity main that discharges to the effluent pump station in front of the control building.

Photo: UV Disinfection System in the Wastewater Control Building

2.6 Effluent Pump Station

The effluent pump station sits on the south side of the control building. This pump station is designed to send treated effluent to the outfall located in Carvers Harbor. The pump station is a submersible duplex station set up in a similar manner to the collection system pump stations discussed in section 3 of this report. The station is rated for 220 gpm and is powered/controlled out of the WWTF. The top of the slab elevation at the effluent wet well is approximately 20.0 FASL. The surrounding ground elevation is approximately 18.5 FASL.

Photo: Effluent Pump Station

2.7 Effluent Outfall and Diffuser

The finished effluent from the WWTF is pumped from the effluent pump station south on Sands Road, through the ferry terminal parking lot, and discharges in the manhole at the top of the hill in Grimes Park adjacent to the ferry loading area. The effluent flows to a concrete diffuser approximately 330 linear feet offshore in Carver's Harbor. The three 2-inch diffuser ports are approximately 20 feet below mean low water. The Grimes Park location was chosen for the outfall as a result of modeling that concluded that a significant amount of mixing and dilution would be provided even under extreme low tide velocity conditions.

3. COLLECTION SYSTEM

The wastewater collection system consists of multiple miles of horizontal infrastructure including gravity sewer, pressure sewer, and force mains. The system also includes 9 pump stations in low lying areas that collect flow from portions of the system's gravity sewers and pump it to higher elevations where it can flow by gravity again. Since construction, some of the pump station have had pump replacements, although the structure, design and operation of the stations has remained largely unchanged since construction. **Table 3-1** is a summary table of key information for each pump station in the collection system.

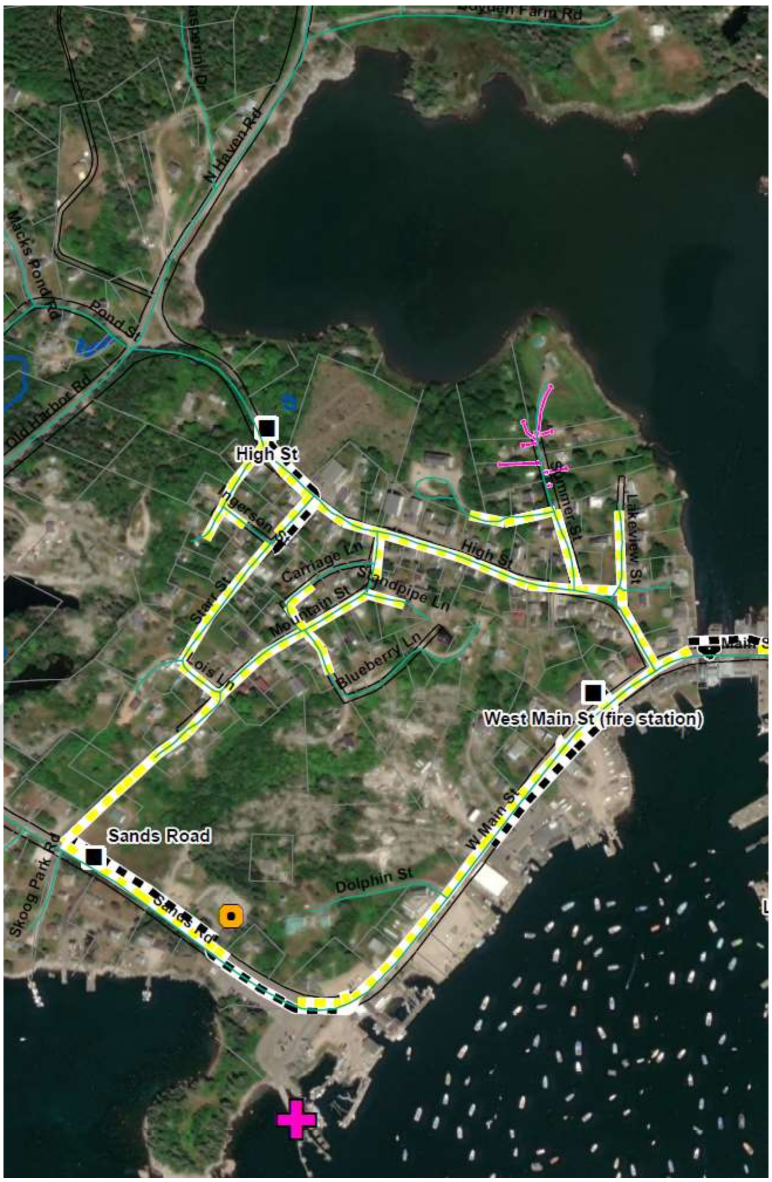
Table 3-1: Vinalhaven Pump Stations

Pump Station Name	Approximate Address	Top of Wet Well Cover Slab Elevation (FASL)	Pumping Capacity (GPM)	Wet Well Storage Volume (Gallons)
West Main Street (Fire Station)	56 West Main Street	12.50	300	9,670
Atlantic Avenue (Lanes Island)	6 Lanes Island Road	12.00	175	5,285
High Street	65 High Street	36.00	175	5,375
Indian Creek	7 Indian Creek Road	11.50	150	5,350
Sands Road	40 Sands Road	14.00	400	3,980
Main Street Pump Station	5 Windy Way	10.00	300	8,370
Leo's Lane	16 Leo's Lane	10.08	150	5,540
Chestnut Street	33 Chestnut Street	23.50	150	5,825
School Street	50 School Street	12.00	125	5,575

3.1 West Side of Collection System

The western portion of the collection system serves the areas on Sands Cove, Western Carvers Harbor, Western Carvers Pond, and Harbor Hill. There are three pump stations on this side of town – High Street, Sands Road and West Main Street (see **Figure 3-1**).

Figure 3-1: West Side of Vinalhaven Collection System



3.1.1 High Street Pump Station

The High Street Pump Station is located just west of the intersection of High Street and Ingerson Road The station collects gravity flow from High Street, Ingerson Road, and the north section of Starr Street. Flow is then pumped back up High Street and Starr Street via a 4-inch force main that discharges into the manhole at the intersection of Starr Street and Ingerson Road. The pump station is just off the road with a grade elevation of approximately 35.00 FASL. The collection area for the High St. Pump Station includes, approximately 32 users including single family and commercial users. Assuming an average daily flow of 100 gallons per day (GPD) per user, the wet well is estimated to be able to store approximately 40 hours of average flows if the station were to not operational.

3.1.2 Sands Road Pump Station

The Sands Road Pump Station is located at 40 Sands Road and is approximately 0.1 miles from the WWTF. The station collects gravity flow from Sands Road to the east and the remaining portion of Harbor Hill to the north. Flow from Starr Street, Mountain Street, East Mountain Street, Mountain Street Lane, and Blueberry Lane arrives at the station via a cross country gravity main running down Mountain Street Extension. Flow is then pumped east on Sands Road via a 4-inch force main to the influent valve manhole at the WWTF. The pump station is just off the road with a grade elevation of approximately 13.00 FASL. The collection area for the Sands Road Pump Station includes, approximately 90 users including primarily single family users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 11 hours of average flows if the station were to be not operational.

Photo: Sands Road Pump Station

3.1.3 West Main Street (Fire Station) Pump Station

The West Main Street Pump Station is located at the Fire Station. The pump station collects gravity flow from West Main Street, High Street, Lakeview Street, Summer Street, Adelo Street, and the north portion of Mountain Street, as well as pumped flow from the east side of town which discharges from the 4-inch force main bridge crossing into the manhole on Main Street in front of Camden National Bank. This station also handles flow from a 2-inch low pressure line servicing two grinder stations on Lakeview Street Extension and a 2-inch low pressure line servicing two grinder stations on West Main Street and stubs for future grinder stations. Flow is then pumped west on West Main Street, around the bend, to the influent valve manhole at the facility via a 6-inch force main. The pump station is on the east side of the fire station with a grade elevation of approximately 11.50 FASL.

The West Main Street Pump Station has a dedicated permanent backup diesel generator to power the station in the event of an emergency. The generator is located on the backside of the fire station. At a ground elevation of approximately 18 FASL. The collection area for the West Main St. Pump Station includes, approximately 230 users including single family, commercial, industrial, and municipal users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 10 hours of average flows if the station were to be not operational.

3.2 East Side of Collection System

The eastern portion of the collection system serves the areas around Eastern Carvers Pond, Downstreet, Eastern Carver's Harbor, Indian Creek, and Pequot Road. There are six pump stations on this side of town (see **Figure 3-2**).

Figure 3-2: East Side of Vinalhaven Collection System

3.2.1 School Street Pump Station

The School Street Pump Station is located at the southwestern corner of the ball field near the intersection of East Boston Road and School Street. The station collects gravity flow from the eastern portion of School Street, East Boston Road, East Main Street, Claytor Hill Road, Cottage Street, Pequot Road, Beaver Dam Road, and Arcola Lane. Flow is then pumped east on School Street, north on East Boston Road, and west on East Main Street via a 4-inch force main that discharges into the manhole at the intersection of East Main Street and Pleasant street. The pump station is just off the road with a grade elevation of approximately 11.00 FASL. The collection area for the School Street Pump Station includes, approximately 57 users including single family and commercial users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 23 hours of average flows if the station were to be down unexpectedly.

Photo: School Street Pump Station

3.2.2 Indian Creek Road Pump Station

The Indian Creek Road Pump Station is located near the intersection of Indian Creek Road and Frog Hollow Road. The station collects gravity flow from Indian Creek Road, Frog Hollow Road, and the western portion of School Street. Flow is then pumped west on Indian Creek Road and Frog Hollow Road via a 4-inch force main that discharges into the manhole at the intersection of Atlantic Avenue and Frog Hollow Road. The pump station is just off the road with a grade elevation of approximately 10.50 FASL. The collection area for the Indian Creek Road Pump Station includes, approximately 31 users including single family and commercial users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 41 hours of average flows if the station were to be not operational.

3.2.3 Atlantic Avenue (Lanes Island) Pump Station

The Atlantic Avenue Pump Station is located near the Lane's Island Bridge. The station collects gravity flow from the southern portion of Atlantic Avenue and from a 2-inch low pressure main serving twelve grinder stations on Round the Mountain Road. Flow is then pumped north on Atlantic Avenue via a 4-inch force main that discharges into the manhole just south of the intersection of Atlantic Avenue and Atlantic Avenue Extension. The pump station is just off the road with a grade elevation of approximately 11.00 FASL. The collection area for the Atlantic Avenue Pump Station includes, approximately 23 users including single family and commercial users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 55 hours of average flows if the station were to be down unexpectedly.

Photo: Indian Creek Road Pump Station

3.2.4 Leo's Lane Pump Station

Photo: Leo's Lane Pump Station

The Leo's Lane Pump Station is located at the end of Leo Lane. The station collects gravity flow from Leo Lane and Clamshell Alley. Flow is then pumped east on Leo's Lane via a 4-inch force main that discharges into the manhole at the intersection of Leo Lane, Water street, and Atlantic Avenue. The pump station is just off the road with a grade elevation of approximately 9.00 FASL. The collection area for the Leo's Lane Pump Station includes, approximately 35 users including single family, municipal and commercial users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 38 hours of average flows if the station were to be down unexpectedly.

3.2.5 Chestnut Street Pump Station

The Chestnut Street Pump Station is located at the end of Chestnut Street. The station collects gravity flow from Chestnut Street that is pumped back up the street via a 4-inch force main that discharges at the intersection of East Main Street and Chestnut Street. The pump station is just off the road with a grade elevation of approximately 22.50 FASL. The collection area for the Chestnut Street Pump Station includes, approximately 12 single family home users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 117 hours of average flows if the station were to be down unexpectedly.

3.2.6 Main Street Pump Station

The Main Street Pump Station is located behind the Fox Island Electric office and opposite the Town Garage. The station collects gravity flow from Main Street, Water Street, Atlantic Avenue, Carvers Street, Lloyd Lane, Brighton Avenue, and Pleasant Street. This station also collects flow from the other five stations on the eastern portion of the system as well as a 2-inch low pressure system serving 4 grinder stations on Atlantic Avenue Extension. Flow is then pumped west behind the businesses on Main Street, south between the IGA Grocery Store and the Post Office, west on Main Street, and across both bridges via a 4-inch force main that discharges into the manhole in front of Camden National Bank. The station also includes a 2,500 gallon storage structure that will fill up should the pump station experience high flows not able to be pumped by the station. The pump station is in a grassy area with a grade elevation of approximately 9.00 FASL. The collection area for the Main Street Pump Station includes, approximately 260 single family home users. Assuming an average daily flow of 100 GPD per user, the wet well is estimated to be able to store approximately 8 hours of average flows if the station were to be down unexpectedly.

Photo: Main Street Pump Station

3.3 Portable Generator

Temporary power at all of the collection system pump stations, besides West Main Street Pump Station, is provided by a portable generator. This diesel generator is mounted to a trailer that can be hauled around to the various pump stations and connected to each station at their dedicated generator connection port. There is only one portable generator for use by the Town to backup power to all of the pump stations. If multiple pump stations were to lose power the single generator would need to be rotated frequently allowing the stations to pump down their contents.

Photo: Portable Generator

3.4 Pump Station Electrical & Controls

Power from the utility to the pump stations is run underground and there are no overhead wires associated with the pump stations. Each of the collection system pump stations is equipped with a stainless steel electrical/controls enclosure. The enclosure opens on two side to allow separation of the electrical components from the control components. The electrical meters and communications junction boxes for the pump stations are located on the outside of the enclosures approximately 2.5 ft above the top of wet well slab elevations presented in table 3-1. Power and controls conduits to and from the wet well enter the enclosure approximately 1 ft above the top of the wet well slab elevations. The physical electrical and controls panels are located approximately 1.5 ft above the top of the wet well slab elevations.

The pumps and level measurement devices in the pump station wet wells are submersible and are designed to be underwater. Flooding of the wet well will have minimal effect on the pumping and controls equipment in the wet well.

3.5 Individual Grinder Pump Stations

There are four low pressure sewer systems in the Town located on Round the Mountain Road, Mary Wentworth Road, Summer Street and Ava Street. Each user in these areas has a grinder pump unit which collects gravity flow from the building and discharges to the 2-inch pressure main. The wet well basin is a 24-inch diameter x 90-inch deep basin constructed of fiberglass reinforced polyester resin. There are approximately 20 of these individual grinder pump stations in the collection system.

3.6 Horizontal Infrastructure

Horizontal infrastructure, although primary underground, can also be susceptible to flooding impacts. Pressure sewer and force mains are pressurized and are not a concern for flood waters entering the system. Manholes are an essential part of any gravity sewer system. These manholes extend from the piping below ground to the roadway or ground surface. The manhole covers installed in Vinalhaven as well as most other communities are not watertight. If flood waters were to cover a manhole, some amount of water would be leaking into the sewer system increasing the flows to the pump stations and WWTF. These flood waters could overwhelm the systems causing hydraulic limitations as well as increase the chloride concentration in the wastewater leading to corrosion impacts as well as microbial heath for the WWTF's biological systems.

4. NATURAL HAZARDS IMPACTING THE WASTEWATER SYSTEM

Vinalhaven's wastewater system may be impacted by a number of different natural hazards including:

- Increased Precipitation
- Flooding of the Wastewater Facility, Pump Stations and Collection System
- Severe Storms & Storm Surge
- Sea Level Rise
- Drought
- Temperature Changes

The sections below describe in more detail these specific natural hazards and how and why they impact the wastewater system.

4.1 Increased Precipitation

Precipitation intensity, duration and severity can impact wastewater utilities by facility, pump station or collection system inundation, an increase in sewer overflows and an increase in the pollutants and sediments entering the wastewater system.

Following storm events, wastewater collection systems may experience an increase in flow or inflow and infiltration (I&I). I&I is the stormwater and/or groundwater flow that is captured by a wastewater collection system. The flow increase can be from things like unknown sump pumps connected to the collection system or leakage into collection system pipes due to age and condition.

Vinalhaven's system was designed to handle a normal wastewater capacity from residential homes and commercial businesses. Currently, there is capacity to handle additional flow however I&I can impact the existing treatment process by disturbing the balance of microbiological organisms. During heavy precipitation events, Vinalhaven has occasionally doubled the amount of water treated due to sump pumps from homes and businesses pumping into the system.

4.2 Flooding of the Wastewater Facility, Pump Stations and Collection System

In Vinalhaven, the type of flooding that could impact the wastewater system is coastal or from heavy precipitation events, or both. Some of Vinalhaven's wastewater system assets are located in an identified FEMA Floodplain area (see **Figure 2 in Appendix A** and **Table 4-1**).

Table 4-1: Wastewater System Assets in FEMA Floodplain

Wastewater System Asset	Located in Floodplain	Top of Wet Well Cover Slab Elevation (FASL)	Nearest Base Flood Elevation Identified on FEMA FIRM Map
* Wastewater Treatment Facility	No	19.37 (finish floor elevation)	19
West Main Street (Fire Station)	Yes	12.50	13
Atlantic Avenue (Lanes Island)	Yes	12.00	13
High Street	No	36.00	N/A
Indian Creek	Yes	11.50	10
Sands Road	Yes	14.00	19

Wastewater System Asset	Located in Floodplain	Top of Wet Well Cover Slab Elevation (FASL)	Nearest Base Flood Elevation Identified on FEMA FIRM Map
Main Street Pump Station	Yes	10.00	13
Leo's Lane	Yes	10.08	13
Chestnut Street	No	23.50	N/A
School Street	Yes	12.00	10

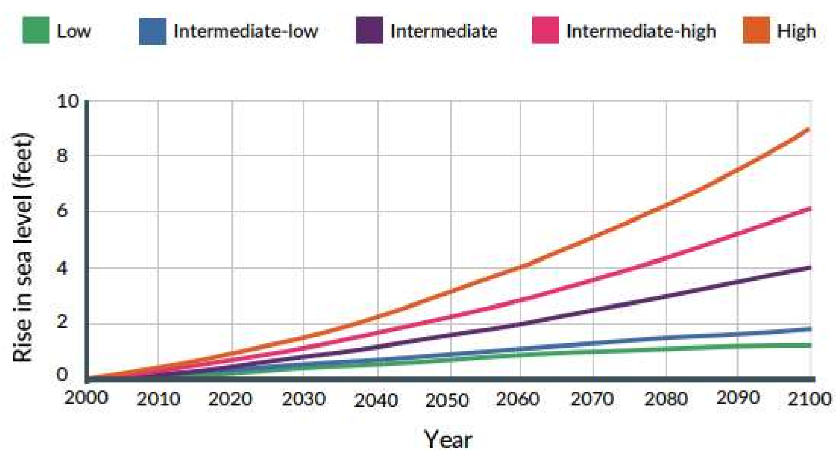
Note: * For the wastewater treatment facility, we note the finish floor elevation.

The Base Flood Elevation (BFE) is the level at which floodwater is anticipated to rise during the base flood. The base flood is the (or the 100-year storm) is the flood that has a one percent chance of being equaled or exceeded in any given year – it can happen multiple times on one year or not for a couple of hundred years. The BFE is used as a regulatory requirement for the elevation or floodproofing of structures as well as for determining flood insurance premiums.

4.3 Sea Level Rise

The United States Army Corps of Engineers developed a sea level calculator to help visualize sea level rise scenarios from tide gauges in the NOAA National Water Level Observation Network. Potential future conditions using the Bar Harbor, Maine tide guage and NOAA 2017 regional scenarios for New England are indicated in **Figure 4-1**.

Figure 4-1: Potential Future Sea Level Rise Conditions



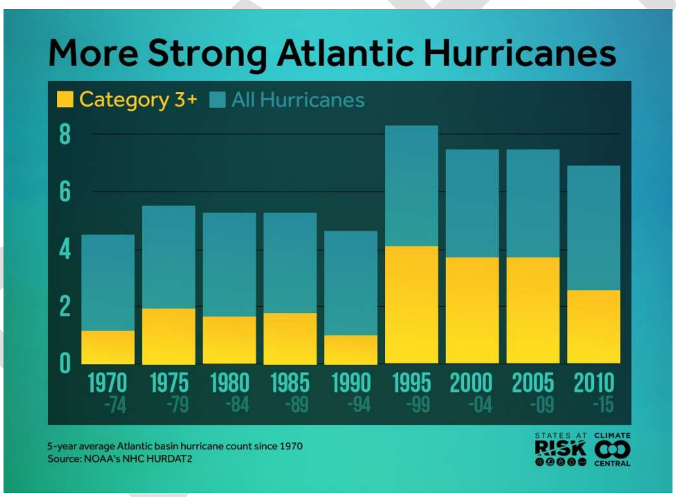
While globally, sea level rise has increased by approximately eight inches since the late 1800s, in Maine, due to the Gulf of Maine being impacted by the gulf stream and wind patterns that change seasonally, it is projected that sea level rise will occur in this area of the country faster than the rest of the world.

Recent data from the Maine Geological Survey indicated the potential extent of sea level rise under various emission scenarios along the Maine coast on top of Highest Astronomical Tide.[1] For reference, it is helpful to know the Highest Astronomical Tide elevation for Vinalhaven which is 6.5 feet (NAVD88)[2]. NOAA references the HAT as the elevation of the highest predicted astronomical tide expected to occur at a specific tide station.This dataset indicates the potential inland extent of inundation from several scenarios (1.2, 1.6, 3.9, 6.1, 8.8 and 10.9 feet) of sea level rise or storm surge along the Maine coastline on top of the Highest Astronomical Tide. **Figure 3 in Appendix A** illustrates the impact potential on Vinalhaven's wastewater system.

4.4 Severe Storms & Storm Surge

NOAA data indicates that hurricanes associated with the Atlantic Ocean have been increasing since 1970 (see **Figure 4-2**). Storm surge and associated wave impacts, high wind and heavy precipitation from severe storms pose a threat to wastewater system assets that are located in areas where this is a risk factor.

Figure 4-2: 5-Year Average Atlantic Basin Hurricane Count Since 1970



Wave forces can cause direct damage to property, equipment and buildings and/or expose them to flood waters. This type of hazard can also cause erosion to land areas surrounding wastewater facilities or pump stations. Other impacts

[1] The sea level rise scenarios were developed by using available long-term sea level rise data from Portland, Bar Harbor, and Eastport tide gauges and the US Army Corps of Engineers Sea-Level Change Curve Calculator and sea level rise scenarios established by NOAA (2017) prepared for the US National Climate Assessment.
[2] *Source: Maine Geological Survey Highest Astronomical Tide Line*

of a hurricane, severe storm and associated surge can range from power outages to acute serious physical damage of equipment and pumps resulting in overflow conditions. Secondary issues depending on the severity and duration of a storm event which may be harder to realize initially are include cracks, leaks and breaks in the collection system that need to be repaired. The combination of increasing storm frequency and sea level rise will increase damages associated with waves and storm surges. Facilities or assets not currently prone to exposure to sea water may become prone in future years.

The Maine Geological Survey prepared Sea Lake and Overland Surges from Hurricanes (SLOSH) maps to be used for planning purposes. The data indicated areas along the coastline that may be inundated by a Category 1, 2, 3 or 4 hurricane at mean high tide. **Figure 4 in Appendix A** illustrates the inundation potential for Vinalhaven's wastewater system.

4.5 Drought

Data from Climate Central indicates that Maine is projected to see a 70% increase in the threat of widespread summer drought by 2050. Drought conditions can disrupt wastewater treatment through water shortages by potentially slowing normal of flow of sewage through the system and cause solids accumulation or blockages. In addition, the flow can change in a way which leads to increased contaminants that may be pumped into the receiving water.

4.6 Temperature Changes

The 2015 Maine's Climate Future report indicates that between 1895 and 2014, the average annual temperature in Maine warmed by three degrees. According to data from Climate Central, in Maine, by 2050, it is anticipated that the number of heat wave days per year will go from 10 to nearly 40. By 2100, the summer temperatures will be approximately 9.4 degrees hotter, a condition that is similar to the current conditions of Newport News, Virginia.

In general, receiving water bodies for wastewater effluent have sensitive ecosystems that can be impacted by the temperature of the water being released. In some cases, there is a need to cool effluent before discharging. Wastewater treatment facilities also must manage the potential for bacteria population increases at different temperatures – even minor temperature changes can have significant effects on biological reactions.

The Vinalhaven wastewater system was designed based on certain parameters and as climate conditions change, they may need to be adjusted or modified based on new assumptions.

4.7 Changing Climate Conditions

The most recent **National Climate Assessment (NCA)** evaluates climate change throughout the United States and includes region specific impacts. In the Northeast, current climate conditions are diverse while future climate change impacts may be seen from rising temperatures, more severe coastal and riverine flooding, sea level rise, extreme precipitation events, storm surge and drought conditions. The following changes have been observed for the Northeast region:

- Between 1895 and 2011, temperatures in the Northeast increased by almost two degrees Fahrenheit,
- Between 1895 – 2011, precipitation increased by almost five inches (or more than 10%),
- The increase in extreme precipitation in the Northeast is higher than any other region in the country,
- Between 1958 – 2010, the increase in the amount of precipitation during heavy events increased more than 70%, and
- Coastal flooding has increased due to a rise in sea level of nearly 1 foot since 1900.

The **Environmental Protection Agency (EPA)** through its Climate Ready Utilities program also anticipates the following observed and projected changes for the Northeast:

- Less snow events and more rain during the winter months as well as a shorter timeframe with more than 20 fewer days below freezing,
- Reduction in snowpack and earlier snowmelt,
- Short term droughts,
- Sea level rise at a rate more than the global average – between 1 to 4 feet by 2100,
- Flooding due to the combination of sea level rise and heavy precipitation occurring more regularly,
- Increased extent and frequency of storm surge and coastal flooding which would cause secondary impacts of property damage, erosion and wetland impacts.

4.8 Future Climate Conditions

The Island of Vinalhaven has been proactive in understanding and planning for potential impacts from natural hazard events including flooding, sea level rise and storm surge. In 2016, the Sea Level Rise Committee was formed and they have been working diligently to understand and communicate about Vinalhaven's broad vulnerabilities. The Town also conducted a more in depth look at coastal flood hazards with future sea level rise in 2017 (see **Appendix B** for the final summary memo associated with this previous work). Work included:

- Reviewing the North Atlantic Coast Comprehensive Study (NACCS) that was completed by the United States Army Corps of Engineers (USACE) in 2015, and

- Development and validation of a new, highly detailed, numerical model for simulating tides, storm surge and waves in Penobscot Bay and the vicinity.

The NACCS review determined that the model results under predicted actual storm surge water levels and that the model results may underestimate the coastal flood hazard for Vinalhaven. The new numerical model that was developed with a focus on Penobscot Bay used the same general techniques used by USACE in the NACCS but downscaled the data to provide higher resolution and accuracy for Vinalhaven. This scenario based flood hazard information was further enhanced by considering probability of sea level rise and the results can be used for future planning purposes. Specific sea level rise scenarios don't need to be considered because the hazard information produced includes increased in the hazards due to the full range of sea level rise scenarios.

This process recommended that Vinalhaven take an adaptation approach focused on risk reduction and use future hazard information as a basis for risk informed decision making. While no specific scenarios were highlighted to plan for during the previous process, for this assessment, it is recommended that Vinalhaven plan for the **BFE plus three feet of sea level rise** which is between the Intermediate Low and Intermediate scenarios illustrated in **Figure 4-1**. Information utilized during this planning process was considered during the risk assessment process for the wastewater system.

5. SYSTEM VULNERABILITIES & CONSEQUENCES

Vinalhaven's wastewater system is vulnerable to natural hazard events and should it be impacted, the consequences would affect the infrastructure, economy and environment. The majority of the impacts will be to the gravity and force mains and the pump stations. The wastewater control building and tanks are at higher elevations and are not the most vulnerable assets.

5.1 Previous System Impacts

To date, Vinalhaven's wastewater system has not been significantly impacted by a natural hazard event such as flooding, heavy precipitation, sea level rise, hurricane or drought. Some minor issues have occurred in the past including:

- Power outages at the wastewater treatment facility control building.
- At the Sands Road Pump Station a manhole was found to be bubbling water due to a power outage from a lightning storm event. The breakers were tripped in the pump station but there was no notification because the power was out. The pump station had a minor failure but once the breaker was reset and the power turned back on, the situation was resolved.
- Minor pump failures have occurred in the past but not due to natural hazard events, due to other issues.
- The Lanes Island pump station has had some I&I issues when a high tide comes in with water coming in from the electrical conduit. Maine Water has been notified about the situation.

5.2 Vulnerable Assets

Vinalhaven's wastewater system does have assets that are vulnerable to a number of the natural hazards discussed in the previous sections. **Table 5-1** summarizes the assets that may be vulnerable to flooding and potential sea level rise. The entire wastewater system and its assets are vulnerable to storm events that have high winds associated with them. This information was used during the risk assessment that was completed for this project.

Table 5-1: Wastewater System Vulnerabilities

Critical Assets of the Treatment System	Vulnerable to Flooding	Vulnerable to Sea Level Rise	Vulnerable to Wave Impacts and Storm Surge	Notes
Gravity Mains	X	X	X	Most at risk in the Main Street, sands Road areas.
Force Mains	X	X	X	Most at risk in the Main Street area and along Sands Road.
Main Street Pump Station	X	X	X	Most at risk to flooding, SLR and wave impacts/storm surge.
Indian Creek Pump Station	X	X		Most at risk for flooding and SLR.
Leo's Lane Pump Station	X	X	X	Most at risk to flooding, SLR and wave impacts/storm surge.

Critical Assets of the Treatment System	Vulnerable to Flooding	Vulnerable to Sea Level Rise	Vulnerable to Wave Impacts and Storm Surge	Notes
Atlantic Avenue (Lane's Island) Pump Station	X	X	X	Most at risk to flooding, SLR and wave impacts/storm surge.
School Street Pump Station	X	X		Most at risk for flooding and SLR.
Sands Road Pump Station	X	X		May be impacted during higher sea level rise scenarios.
West Main Street (Fire Station) Pump Station	X	X		May be impacted during higher sea level rise scenarios.

Table 4-1 indicated the elevation of the asset and then the nearest Base Flood Elevation (BFE) identified from the FEMA Floodplain map. The assets most at risk for being impacted by a flood event include:

- School Street Pump Station
- West Main Street (Fire Station) Pump Station
- Atlantic Avenue (Lanes Island) Pump Station
- Indian Creek Pump Station

5.3 Natural Hazard Impacts to the Wastewater System

Understanding how climate change may impact existing wastewater infrastructure is complex and depends on the variables discussed in previous sections.

Due to the inherent design of collection systems flowing into treatment facilities or pump stations at low elevations, the possibility of **flooding** is of concern. Inundation of wastewater system assets can result in overflow discharges into the receiving surface water. Other concerns include:

- Electrical equipment submersion,
- Disruption of biological treatment processes,
- Sewer overflows (Due to I/I) which results in untreated wastewater discharging to a receiving surface water.
- Human exposure is a concern during flood events because untreated wastewater can flow out of the sewer system and impact public health by entering basements and causing groundwater contamination.
- Loss of power or back up power failures, and
- Structural damage due to repeated flood exposure.

Wind damage from storm events can also cause damage to infrastructure, such as:

- Structural damage to buildings, equipment and pump stations from actual wind force and/or debris that may be present during a storm event,
- Inability to access components of the wastewater system due to impassable roads,
- Power outages that may result in system malfunctions or the inability to function at all, and

- Cutting out communication abilities during a storm event leaving the infrastructure and people charged with maintaining and fixing it during emergencies vulnerable.

Damage from **wave impacts and storm surge** when infrastructure is located in at risk areas can be substantial. The force of waves and storm surge can cause the following issues:

- Physical damage to buildings, equipment and pump stations,
- Erosion of soil, particularly if there is minor vegetation in the area which can weaken the foundation of a structure or pipe structure, or
- Impacts from debris or sand that may be transferred during a storm events.

Rising surface waters that submerge wastewater infrastructure assets due to **sea level rise** can cause result in the following challenges:

- Disabling wastewater system components such as pump stations either temporarily or permanently,
- Modification or reduction of hydraulic capacity of the treatment facility,
- Elimination of the ability to access an asset of the wastewater system (the facility or pump stations) by vehicle or on foot,
- Buoyancy and corrosion of pipes,
- Inability to access valves and manholes,
- Removal of above ground system components due to surface water levels or inundation of in ground components due to infiltration,
- Wave impacts to wastewater system assets that are not designed to withstand wave forces or erosion, and
- Detrimental impacts to other infrastructure (roadways, bridges) that the wastewater system relies on for pipe locations and wastewater flow movement.

The Environmental Protection Agency (EPA) Adaptation Strategies Guide for Water Utilities specifically identified many challenges that will be faced by wastewater utilities throughout the country as a result of **climate change**. Those that particularly apply to the resiliency of Maine wastewater treatment facilities and infrastructure systems include flooding caused by high flows and coastal storm surges, and loss of coastal landforms and wetlands. While much of the existing wastewater infrastructure in Maine will be exposed to new risks caused by the impacts of climate change, current challenges are also likely to be intensified

Wastewater system overflows that occur due to any natural hazard event can result in contaminated water which is an issue because the water may be used for recreation, irrigation or other purposes which can be harmful to humans and animals. As a major fishing community, closure of surface waters due to contamination would be a massive negative consequence to Vinalhaven.

5.4 Risk Assessment

Understanding the risk to Vinalhaven's wastewater system based on potential natural hazard impacts will allow the Town to make informed decisions about improvements or other mitigation efforts. A risk assessment was performed to identify the criticality of the various wastewater system components (wastewater treatment facility, pump stations, collection system) and help prioritize these assets for possible risk mitigation projects.

Risk assessment is a method for identifying system vulnerabilities, prioritizing mitigation projects, and optimizing capital expenditures. Risk is the combination of how likely it is an asset could fail, and the resulting impact of that failure. These concepts are represented in the risk analysis by Consequence of Failure (CoF), and Likelihood of Failure (LoF). The results of this analysis were utilized to identify recommendations or adaptation strategies.

5.4.1 Consequence of Failure Assessment

The Consequence of Failure (CoF) assessment focused on how important the various wastewater assets are to the Town based on their role in the system, and the resulting impact in the case the asset was no longer functional. The CoF was evaluated based on the impact if the asset had been damaged to the point it was non-functional.

The CoF for each asset was scored based on the impact its failure could have to the following four categories:

- **Public Health and Safety:** This category focused on the likelihood a failure of each asset could cause injuries (or death) or a significant health impact. It was assumed the impacts could be caused directly by the actual failure of the structure, or indirectly by failing to provide critical services such as the transport of wastewater.
- **Community Image:** This category concerned how the failure of an asset could affect the reputation of the Town. This includes media coverage, service interruptions, and generally how an asset's failure could affect the ability of the Town to achieve its desired levels of service.
- **Financial:** This category was based on the direct financial replacement value of the asset, using the scale shown in **Table 5-2**. This is a community financial impact and includes private and public cost implications. The costs were estimated based on Woodard & Curran's knowledge of infrastructure costs. Results from this section are provided for high level, planning purposes only. Some specific assumptions made for assets during the scoring for this category include:
    - Gravity and Force Mains: For these assets, because they are not located at one site, it was not assumed failure would result in a total replacement. Instead, the financial impact was assumed to reflect the approximate cost of a major repair or rehabilitation.
    - For wastewater pump stations, the financial impact was assumed based on the number of users or connections to the station. Stations with more than 50 users or connections were given a higher score than those with less than 50 users or connections.
- **Environmental Damage:** In many cases, the failure of an asset may result in environmental contamination. Environmental damage may have an impact from a regulatory perspective. However, Vinalhaven is a community whose economy revenue relies heavily on the ability to use the natural resources for fishing and tourism activities. Maps used for assessment environmental impact are included in **Appendix B**.

The assets were scored for each category on a numeric scale of 1-5, where 5 is a major impact, and 1 is a negligible impact. The scoring methodology is illustrated in detail in **Table 5-2**. The results of the CoF assessment are included in **Appendix B**.

Table 5-2: CoF Scoring Matrix

Health & Safety	Community Image	Financial	Environmental Damage
5. Significant risk of injury or death 4. Significant risk of major injury or health impact. 3. Low risk of major injury or health impact. 2. Low risk of injury or health impact. 1. No Risk of Injury or health impact.	5. Major service interruption, reputation impact and/or national media coverage. 4. Intermittent services, reputation impact and local or regional media attention. 3. Minor service and reputation impacts, no media. 2. No media and reputation impacts, minor intermittent service impacts. 1. No media, reputation or reputation impacts.	5. Greater than $1 million 4. $100k to $500k 3. $50k to $100k 2. $10,000 to $50k 1. Less than $10,000	5. Significant environmental damages. 4. Localized environmental damage. 3. Possible environmental damage. 2. Possible minor or eventual environmental damage. 1. No environmental damage

5.4.2 Likelihood of Failure Assessment

The Likelihood of Failure (LoF) assessment gauges the probability of a failure taking place. The failure modes for this assessment included the most probable hazards for a community highly exposed to open ocean. These include sea level rise, storm surge, and flooding. Failure as a result of these hazards could occur at varying degrees and in this assessment sea level inundation was assumed to be a failure.

The first step in the LoF assessment was to spatially locate the wastewater system assets using GIS information. Each of the scoring categories for this analysis were based on GIS layers, which show the areas in the Town that could be affected by different natural hazards. Each category is described below:

- **Sea Level Rise:** Recent data from the Maine Geological Survey indicated the potential extent of sea level rise under various emission scenarios along the Maine coast on top of Highest Astronomical Tide.[1] This dataset indicates the potential inland extent of inundation from several scenarios (1.2, 1.6, 3.9, 6.1, 8.8 and 10.9 feet) of sea level rise or storm surge along the Maine coastline on top of the Highest Astronomical Tide. Vinalhaven's wastewater system assets were scored based on whether they fell into a Sea Level Rise zone and the extent of inundation of that zone. Assets that will be impacted in more of the near term received a higher ranking.
- **SLOSH Zone:** The Maine Geological Survey prepared Sea Lake and Overland Surges from Hurricanes (SLOSH) maps to be used for planning purposes. The data indicated areas along the coastline that may be inundated by a Category 1, 2, 3 or 4 hurricane at mean high tide. Vinalhaven's wastewater system assets were scored based on whether they fell into a Sea Level Rise zone and the extent of inundation of that zone. Assets that will be impacted by a Category 1 received a higher ranking.

[1] The sea level rise scenarios were developed by using available long-term sea level rise data from Portland, Bar Harbor, and Eastport tide gauges and the US Army Corps of Engineers Sea-Level Change Curve Calculator and sea level rise scenarios established by NOAA (2017) prepared for the US National Climate Assessment.

- **FEMA FIRM National Flood Hazard Maps:** "FIRM is an official map of a community that displays the floodplains, more explicitly Special Flood Hazard Areas (SFHA) and Coastal High Hazard Areas (CHHA), as delineated by FEMA. Both areas are subject to inundation by 1-percent-annual chance flood."[1] The scoring for this category was based on whether an asset fell into one of these areas.

Table 5-3 details the LoF Scoring Matrix that was used to develop the risk rank for each wastewater asset. The results of the LoF assessment are included in **Appendix B**.

Table 5-3: LoF Scoring Matrix

Sea Level Rise	Hurricane Surge Inundation Zones	FEMA FIRM National Flood Hazard Maps
5: Affected by 1.2-ft. SLR 4: Affected by 1.6-ft. SLR 3: Affected by 3.9-ft. SLR 2: Affected by 6.1-ft. SLR 1: Affected by 10.9-ft. SLR	5: Category 1 Hurricane 4: Category 2 Hurricane 3: Category 3 Hurricane 2: Category 4 Hurricane 1: Not within a SLOSH surge area	5: Coastal High Hazard Areas 4: Special Flood Hazard Areas *3:* Just outside FEMA zone *2: Not Used* 1: Not within a FIRM area

Based on the LoF and CoF assessments, the risk scores were determined for each wastewater asset (see **Table** 5-4). Risk is the product of the numerical metrics of LoF and CoF (Risk = CoF x LoF).

Table 5-4: Wastewater System Asset Risk Ranking

	LoF	CoF	Risk	Risk Rank
Main Street Pump Station	5	3.75	19	1
West Main Street (Fire Station) Pump Station	4.25	3.75	16	2
Atlantic Avenue (Lanes Island) Pump Station	4.25	3.25	14	3
Gravity Mains	4.25	3.25	14	4
Force Mains	4.25	3	13	5
Leo's Lane Pump Station	4.5	3	14	5
School Street Pump Station	4.25	2.75	12	6
Sands Road Pump Station	3.5	3.25	11	7
Indian Creek Pump Station	3.5	2.75	10	8
Wastewater Treatment Facility	2.25	4.25	10	9
Chestnut Street Pump Station	1.5	2.75	4	10
High Street Pump Station	0.75	3	2	11

[1] Cape Cod Sea Level Rise Viewer. http://gis-services.capecodcommission.org/apps/public/SeaLevelRise/SeaLevelRise.html#MoreInfo Cape Cod Commission 2015. Accessed October 2015.

6. ADAPTATION STRATEGIES FOR THE WASTEWATER SYSTEM

The previous planning and analysis work done to better understand vulnerabilities in Vinalhaven based on projected climate change impacts indicated that options for adaptation fall into three general categories:

- Accommodate – An adaptive strategy that allows for business as usual through changes made to human activities, buildings or infrastructure that would improve overall resilience.
- Protect - A reactive strategy to protect people, property and infrastructure from sea level rise.
- Retreat – An adaptive strategy that limits structural protection, discourages development in areas that are vulnerable and plans for the eventual relocation of buildings and infrastructure to areas with less or no risk.

Previous studies have developed recommendations for Vinalhaven to consider to increase resiliency in general on the island. Based on the recent study for Carvers Harbor and the work of the Sea Level Rise committee, including the Maine Flood Resilience Checklist, the recommendations in **Table 6-1** are relevant to this CAP for Vinalhaven's wastewater system. The CAP also helped advance and support a number of these recommendations which demonstrates progress made by the community.

Table 6-1: Previous Adaptation & Resiliency Recommendations for Vinalhaven

Recommendation	Relevance to the CAP Process for the Wastewater System	Source
Document local and departmental knowledge about flood hazard information including vulnerabilities, impacts and response.	The CAP process included interviewing and working closely with Town staff to discuss flood hazard information including vulnerabilities, impacts and response.	Flood Resilience Checklist
Share information about local flood hazards, vulnerabilities and resilience planning with the Board of Selectmen, volunteer boards and committees, residents and visitors.	The final CAP will be available on the Town's website for the public.	Flood Resilience Checklist
Coordinate with Knox County Emergency Management Agency to develop Town-wide and area-specific GIS maps depicting coastal flooding scenarios and the locations of resources, facilities and infrastructure of interest.	As part of the CAP, the wastewater system infrastructure data available in CAD was overlaid with available FEMA Flood and Sea Level Rise data layers to produce GIS maps that illustrate the vulnerability of various assets. The Town of Vinalhaven did not previously have the wastewater system data available as a GIS layer.	Flood Resilience Checklist
Collect surveyed elevation data on municipal facilities/infrastructure and incorporate the data into a GIS map to overlay flood hazards to identify infrastructure and facilities that will be inundated under certain flood scenarios including wastewater treatment systems.	See above.	Flood Resilience Checklist

Recommendation	Relevance to the CAP Process for the Wastewater System	Source
Develop and implement plans and backup systems for critical infrastructure and facilities to ensure continuation of function of services during and after flood hazard events.	The CAP discusses specific recommendations and needs for the wastewater system to continue functioning during and after flood events.	Flood Resilience Checklist
Incorporate resiliency criteria, flood hazard information, and adaptation and mitigation strategies into capital improvement plans for municipal infrastructure and facilities.	The CAP includes recommendations that can be carried over into capital improvement plans.	Flood Resilience Checklist
Investigate opportunities to protect, elevate and/or relocate wastewater and water treatment facilitys, pump stations and other associated infrastructure to reduce vulnerability to flooding.	The CAP addresses this recommendation specifically.	Flood Resilience Checklist
Perform studies to better understand flood hazard impacts.	The CAP addresses this recommendation specifically.	January 8, 2018 Adaptation Options Memo
Installing a Tide Gate at the Carvers Pond Inlet	This recommendation could potentially provide some flood protection to the Main Street Pump Station by limiting the potential for flooding in the pond.	January 8, 2018 Adaptation Options Memo

Vinalhaven's wastewater system has provided reliable service to the island since it was installed in 2002. The adaptation strategies developed are based on the goal of helping the community understand at what point wastewater infrastructure will be impacted to what extent from flooding, sea level rise and other natural hazard events and what can be done to improve overall resiliency. Recommendations considered:

- State policy recommendations applicable to wastewater infrastructure,
- Asset specific recommendations for short and long term physical and operational measures that can be incorporated to improve overall resiliency, and
- The design life of the wastewater system and recommendations to consider when making improvements based on age that can also increase resiliency.

Adaptation strategies include capital upgrades (such as elevating pump stations, elevating electrical equipment, flood proofing manholes, improving back up power) and softer strategies such as developing protocols for specific situations. **Table 6-2** identifies specific adaptation recommendations for Vinalhaven's wastewater system.

Table 6-2: Adaptation Recommendations for the Wastewater System

No.	Recommendation	Notes
1	Replace or upgrade the existing portable generator used to power the pump stations.	The current portable generator that is available must be hauled around to various pump stations and connected to each one at their dedicated generator connection port. In the past, this has only been done several times. If the Town decides to keep the portable generator as its back up power option for the pump stations, consideration should be given to replacing or upgrading the existing one in the future. As of May 2019, the portable generator has not been used for three years.
2	Remove tree and vegetation overgrowth at all of the pump stations.	The pump stations have significant tree and vegetation overgrowth that has not been managed since they were installed. All of the overgrowth should be removed to allow for easy access to the pump stations during both regular maintenance and emergency or flooding events.
3	Install permanent generators at the pump stations	While the Town is considering replacing or upgrading the existing portable generator that provides back up power to the pump stations, consideration should also be given to whether or not the pump stations should have more permanent generators installed. Currently the West Main Street Pump Station is the only one with its own generator. Other pump stations where permanent generators should be installed to increase resiliency are Main Street, Sands Road, Leo's Lane and School Street.
4	Obtain and store sandbags that can be used to sandbag the main door for the wastewater treatment facility control building and hatches at the pump stations to reduce inundation.	In general, the wastewater treatment facility is at an elevation which precludes it from being impacted by projected flooding and/or sea level rise. There is a concrete sill around the building at elevation 20 that will help protect it from potential flooding. Southerly storms tend to be the issue for the wastewater building, so having sandbags on hand and ready for use at the front door would further prevent any flooding that may occur. Sandbagging hatches at the pump stations could also help reduce any potential inundation.
5	Address flooding concerns at Lanes Island pump station which has seen water intrusion from the electrical conduit in the past due to high tide events.	Each pump station's five electrical conduits should be sealed at entrance to the pump station wet well as well as at the entrance to the electrical enclosure to prevent water/gas migration. If groundwater is entering the conduit due to bad joints or broken conduits, it should be replaced.
6	Elevate electrical equipment at the pump stations.	All of the electrical equipment inside the enclosures at the pump stations should be elevated to a minimum of three feet above the BFE which will provide additional protection from flooding events. If the electrical equipment cannot be moved up inside the existing enclosures, a new elevated concrete equipment pad should be poured and have the existing enclosure moved on top of the pad.

No.	Recommendation	Notes
7	Obtain the necessary parts that will allow staff to replace or rebuild a wastewater pipe or pump should it be damaged or fail.	If a pump needs to be replaced or undergo a factory rebuild, it could take weeks due to the Town's isolated location in Penobscot Bay. Having a stock of recommended wear parts for pipes and pumps will allow for quicker recovery and reduction in potential service interruption should components of the wastewater infrastructure fail or be inoperable. Each pump station is designed for a single pump to handle the peak flows. The second pump acts as a backup should the lead pump fail. It should be the goal to maintain two fully operational pumps for each pump station at all time. If the Town is required replace a failed pump or take a pump out of use for service or repair all efforts should be made to expedite the reinstallation of a fully redundant second pump. A maintenance schedule should be implements and closely followed to ensure pumps are being routinely serviced and in full working order. A strict maintenance schedule will ensure redundancy in pumping capacity should a pump unexpectedly fail.
8	Elevate the electrical control panel at the wastewater treatment facility control building.	Currently the electrical control panel at the wastewater building is approximately 6" from the ground. Although flooding does not appear to be an imminent threat to this building, it would still be prudent to elevate the electrical control panel. It is recommended to elevate the electrical and controls for the station to a minimum height of three feet about the BFE.
9	The West Main Pump Station and Main Street Pump Station manage the most flow in the wastewater system. The Town should have back up pumps available should either of these fail.	The Town currently runs their pumps to failure. Besides a robust maintenance schedule on the pumps, it is important to have contact information for the pump suppliers readily available. The contact information should be current and updated frequently to ensure accurate information is on hand.
10	The wastewater treatment facility control building currently has some moisture intrusion which needs to be repaired.	Kevin, Andy, Gabe – do you have any further notes or knowledge about this?
11	Develop an interim fix for the force main attached to the bridge on Main Street. Should this bridge fail or be flooded, there would be issues with this pipe.	This pipe attached to the Main Street bridge is not redundant and there needs to be a plan established should there be an issue with the bridge that causes the pipeline to fail. Potential fixes may include installing bypass piping vaults on both sides to the bridge. With the bypass option, should the bridge get washed out in a major storm event, a 4" lay flat/fire hose could be connected between the two bypass connections allowing flow to pass overland until a larger repair could be made.

No.	Recommendation	Notes
12	Provide protection against inflow for manholes located in flood prone areas.	During flood conditions, inflow can occur at sewer manhole covers. Upgrading manhole covers in flood prone areas to be water tight will prevent inflow from entering the sewer system. Some manholes outside the roadway may be sand bagged to prevent inflow from entering the system.
13	Develop a flood monitoring protocol for the pump stations to enable advance warning of rising waters surrounding the pump station.	The Town should develop a protocol or install alarms at the pump stations that would be activated when flood waters reach a certain level around the pump station. Level switches could be located inside the electrical enclosures to alert the staff as soon as water reaches the base of the electrical enclosure allowing staff time to mobilize and address the issue.
14	Access to the wastewater treatment facility and some of the pump stations could potentially be limited during certain types of flooding events.	Develop an emergency access protocol that includes maps with pre-planned routes of travel to and from certain areas of the island where critical wastewater infrastructure is located. The maps should assume low lying areas will be flooded and not safe for travel.
15	Elevate School Street Pump Station	The School Street Pump Station has a top of wet well cover slab elevation of 12.0. The Base Flood Elevation on the FEMA Floodplain map for this area is 10. Storm surge and sea level rise scenarios also show the potential for this pump station to be inundated. Moving the pump station would be costly and require the modification of the gravity sewer system. As a secondary option, elevation of the pump station should be considered. The wet well openings and the electrical enclosure can be elevated by adding barrel rings to the WW and an equipment pad under the electrical enclosure.
16	Elevate Main Street Pump Station	The Main Street Pump Station has a top of wet well cover slab elevation of 10.0. The Base Flood Elevation on the FEMA Floodplain map for this area is 13. This pump station came back with the highest ranking after the risk assessment. Storm surge and sea level rise scenarios also show the potential for this pump station to be inundated. Moving the pump station would be costly and require the modification of the gravity sewer system. As a secondary option, elevation of the pump station should be considered. The wet well openings and the electrical enclosure can be elevated by adding barrel rings to the WW and an equipment pad under the electrical enclosure.

7. IMPLEMENTATION PLAN

Vinalhaven's wastewater system is an asset to the community and the following recommendations and adaptation strategies seek to improve, protect and enhance the entire system and its ability to function during various natural hazard events and into the future under changing climate conditions.

For planning purposes, the following timeframes and priority levels have been established:

- **Timeframe**
  - Short – 1 to 5 years
  - Medium – 5 to 15 years
  - Long – 15+ years

- **Priority**
  - High – recommendation should receive top consideration
  - Moderate – recommendation should be weighed against other priorities
  - Low – would be nice to accomplish at some point in time

The information in **Table 7-1** includes a timeframe and priority level for the proposed recommendation and an estimated cost. The cost estimates provided are for planning purposes and they should be updated as the Town decides to proceed with various action items.

Table 7-1: Wastewater System Recommendations

No.	Recommendation	Timeframe	Priority	Estimated Cost	Responsible Party
1	Replace or upgrade the existing portable generator used to power the pump stations.	Medium	High		Town of Vinalhaven
2	Remove tree and vegetation overgrowth at all pump stations.	Short	High		Town of Vinalhaven
3	Install permanent generators at pump stations with high numbers of dependent users.	Medium	High		Town of Vinalhaven
4	Obtain and store sandbags that can be used to sandbag the main door for the wastewater treatment facility control building and hatches at the pump stations to reduce inundation during flood events.	Short	Moderate		Town of Vinalhaven
5	Address flooding concerns at Lanes Island pump station which has seen water intrusion	Short	High		Town of Vinalhaven

No.	Recommendation	Timeframe	Priority	Estimated Cost	Responsible Party
	from the electrical conduit in the past due to high tide events.				
6	Elevate electrical equipment at the pump stations.	Short	High		Town of Vinalhaven
7	Obtain the necessary parts that will allow staff to replace or repair collection system piping and pump station pumps should they become damaged or fail.	Medium	Moderate		Town of Vinalhaven
8	Elevate the electrical control panel at the wastewater treatment facility control building.	Short	High		Town of Vinalhaven
9	Develop a accurate list of pump suppliers that can be easily contacted should a pump replacement or repair need to be made.	Medium	Moderate		Town of Vinalhaven
10	The wastewater treatment facility control building currently has some moisture intrusion which needs to be repaired.	Short	High		Town of Vinalhaven
11	Develop a bypass plan and permanent infrastructure for the force main attached to the bridge on Main Street. Should this bridge fail the force main would likely fail as well.	Medium	Low		Town of Vinalhaven
12	Provide watertight manhole covers for manholes located in flood prone areas.	Short	Moderate		Town of Vinalhaven
13	Develop a flood monitoring protocol for the pump stations to enable advance warning of rising flood waters.	Medium	Low		Town of Vinalhaven
14	Access to the wastewater treatment facility and some of the pump stations could potentially be limited during certain types of flooding events. Develop an emergency access protocol including routes to and from critical wastewater infrastructure that avoids flood prone areas.	Medium	Moderate		Town of Vinalhaven, Maine Water

No.	Recommendation	Timeframe	Priority	Estimated Cost	Responsible Party
15	Elevate School Street Pump Station	Medium	Moderate		Town of Vinalhaven
16	Elevate Main Street Pump Station	Medium	Moderate		Town of Vinalhaven

7.1 Funding Sources

Improvements or recommendations made for the wastewater system may be paid for with local funds. With competing priorities for limited monies, the following resources may also be potential funding mechanisms for some of the recommendations. The wastewater system is Town owned and operated by Maine Water.

- **EPA Federal and State Clean Water Revolving Funds (CWSRF)** - MaineDEP administers these Federal and State Revolving loan Fund. States make low interest loans or other assistance to publicly owned wastewater collection and treatment systems, stormwater systems and nonpoint source pollution control and estuary management projects. The primary purpose of the fund is to acquire, plan, design, construct, enlarge, repair and/or improve publicly-owned sewage collection systems, interceptor sewers, pumping stations, and wastewater treatment plants. In addition, the program also funds public and private non-point source water quality protection and improvement projects; such as landfill closures, sand/salt storage facilities, septic system repair and replacement, storm water projects, agricultural best management practices, and specific silviculture equipment purchases.
- **United States Department of Agriculture Rural Development -** This program provides funding for clean and reliable drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage to households and businesses in eligible rural areas. Local governments are eligible to apply. Areas that may be served include rural areas and towns with populations of 10,000 or less. Long term, low interest loans are available and funds may be used to finance the acquisition, construction or improvement of sewer collection, transmission, treatment and disposal, stormwater collection, transmission and disposal and some solid waste and drinking water projects.
- **Hazard Mitigation Grants -** FEMA awards funds to State, U.S. Territory, and federally recognized tribal applicants, who in-turn provide sub awards to local government Sub-applicants. A local jurisdiction must be included in a current local hazard mitigation plan to be eligible for HMA. Typical project types in Maine include generators for critical facilities, culverts / drainage upgrades, bank Stabilization, acquisition / demolition and elevation. Funding depends on Presidential Disaster Declarations and grant rounds are competitive.
- **Pre-Disaster Mitigation Grant Program** – FEMA administers the PDM program to assist States, U.S. Territories, Federally-recognized tribes, and local communities in implementing a sustained pre-disaster natural hazard mitigation program. PDM grants are funded annually by Congressional appropriations and are awarded on a nationally competitive basis.
- **Maine Municipal Construction Grant Program** - State law gives the DEP flexibility, through the Construction Grant Program, to use bond issue funds with other sources of funding to provide affordable financing of municipal and quasi-municipal wastewater facilities. There is a specific formula to determine a community's eligibility for this program. Under this program, and within the availability of funding, grant amounts can't to exceed 25% of the

costs for preliminary planning of a pollution abatement program and design of a wastewater infrastructure project; and an amount not to exceed 80% of the construction and construction engineering costs for a wastewater infrastructure project, i.e. treatment facilities, sewer systems and effluent outfalls.

- **Maine Coastal Communities Grant Program –** This program funds projects that are designed to improve water quality, increase adaptation to erosion and flooding, restore coastal habitat, promote sustainable development, and enhance the coastal-dependent economy while preserving coastal natural resources. Communities within the Maine coastal zone can apply.

7.2 Next Steps

TBD

APPENDIX A: MAPS

Wastewater System Potential Inundation from Flood Hazard (FEMA Floodplain)
Wastewater System Potential Inundation from Hurricane Category 1-4 Storms (SLOSH Map)
Wastewater System Potential Inundation from Sea Level Rise & Storm Surge

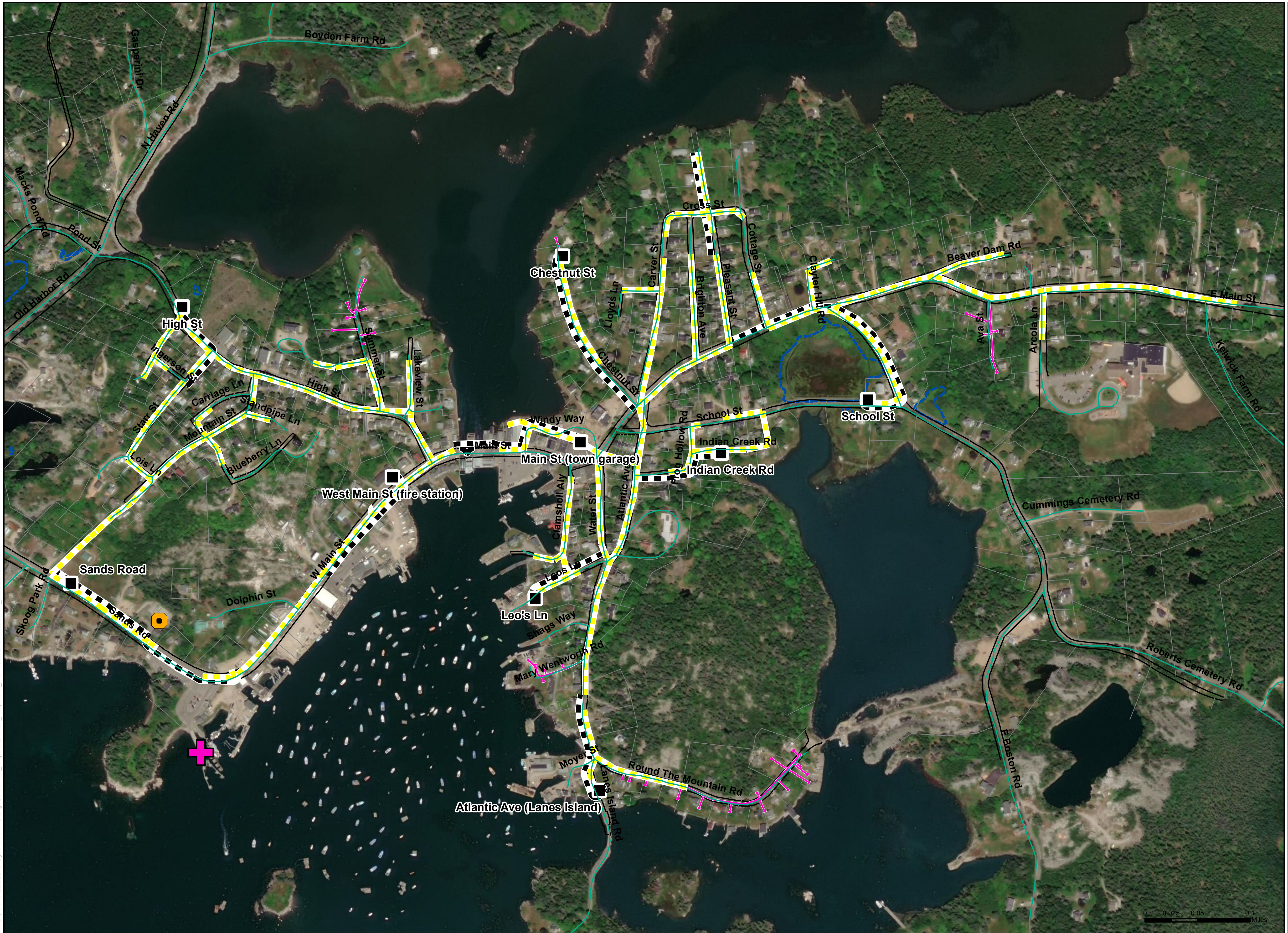


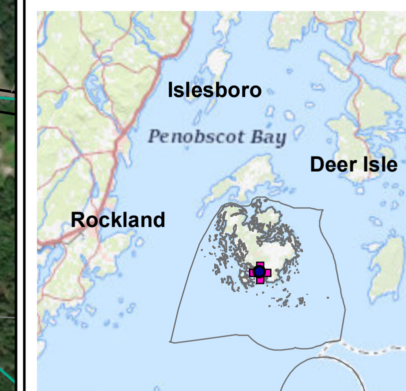
Figure 1

Vinalhaven, Maine

Wastewater System

N

Location Reference



Legend

- Wastewater Treatment Plant
- Pump Stations
- Gravity Mains
- Force Mains
- Pressure Sewer
- Ferry Service
- Parcel Lines

WOODARD & CURRAN

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk.

Data Sources:
Maine Geological Survey; ESRI; GIS User Community; other Federal and third party contributers

Project #: 203109 Map Created by MTR: March 2019

Figure Exported: 5/29/2019 By: mroberts Using: C:\Michelle_Projects\Climate_Adaptation_Plan\Vinalhaven\Vinalhaven_11x17.mxd

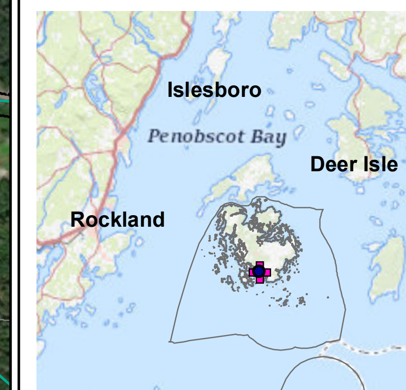
Figure 2

Potential Inundation from Flood Hazard

Vinalhaven, Maine

N

Location Reference



Legend

Preliminary Flood Hazard Zones

- VE
- AH
- AE
- A
- Wastewater Treatment Plant
- Pump Stations
- Gravity Mains
- Force Mains
- Pressure Sewer
- Ferry Service
- Parcel Lines

WOODARD & CURRAN

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk.
Data Sources:
Maine Geological Survey; ESRI; GIS User Community; other Federal and third party contributers

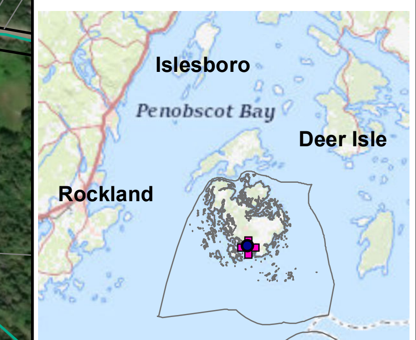
Project #: 203109 Map Created by MTR: March 2019

Figure 3

Potential Inundation from Sea Level Rise and Storm Surge

Vinalhaven, Maine

Location Reference



Legend

Storm Surge Scenarios 2018

- HAT Plus 1.6 Feet
- HAT Plus 6.1 Feet
- HAT Plus 10.9 Feet
- Wastewater Treatment Plant
- Pump Stations
- Gravity Mains
- Force Mains
- Pressure Sewer
- Ferry Service
- Parcel Lines

WOODARD & CURRAN

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Data Sources:
Maine Geological Survey; ESRI; GIS User Community; other Federal and third party contributers

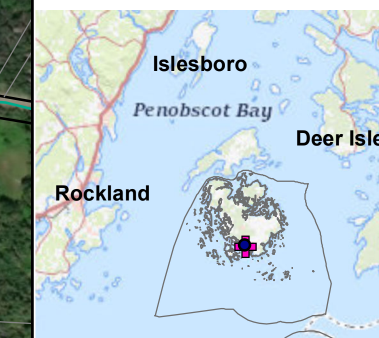
Project #: 203109 Map Created by MTR: March 2019

Figure 4
Potential Inundation from Sea Lake & Overland Surges from Hurricanes

Vinalhaven, Maine

N

Location Reference



Legend

Potential Inundation By Hurricane Category

- Cat 1
- Cat 2
- Cat 3
- Cat 4
- Wastewater Treatment Plant
- Pump Stations
- Gravity Mains
- Force Mains
- Pressure Sewer
- Ferry Service
- Parcel Lines

WOODARD & CURRAN

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk.

Data Sources:
Maine Geological Survey; ESRI; GIS User Community; other Federal and third party contributers

Project #: 203109 Map Created by MTR: March 2019

APPENDIX B: SUPPORTING DOCUMENTATION

Memo

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Byfield, Massachusetts □ Portsmouth, New Hampshire □ Hamilton, New Jersey □ Providence, Rhode Island

www.ransomenv.com

Date:	January 8, 2018
To:	Andrew Dorr, Town Manager, Town of Vinalhaven
From:	Nathan Dill, P.E.
Subject:	Vinalhaven Resiliency Planning – Adaption Options Recommendations

This memorandum summarizes the Sea Level Rise and Storm Surge Analysis we have performed for the Town of Vinalhaven (Town). The purpose of this analysis is to assist the Town in determining the combined risk of coastal flooding due to storm surge and sea level rise in the Downstreet area. This memorandum is also being provided to aid the Town in meeting deliverable requirements for a Coastal Communities Grant that was awarded to the Town through the State of Maine Department of Conservation, Agriculture, and Forestry (DACF), Coastal Program for Fiscal Year 2017.

To date, Ransom has previously provided the Town with a series of four memoranda that document our analysis, provide detailed hazard information, and recommendations for next steps in resiliency planning. In this latest memorandum, discussed herein, we first provide a brief overall summary of the previous analyses, while the reader is referred to the original documents for greater detail. We then discus general recommendations for a variety of adaptation options that the Town may consider when planning to mitigate risks associated with coastal storms and future sea level rise.

SUMMARY OF PREVIOUS MEMORANDUMS

On August 17, 2017, Ransom provided two memoranda to the Town. The first memorandum gives a review of the North Atlantic Coast Comprehensive Study (NACCS) that was completed by the United States Army Corps of Engineers (USACE) in 2015. The second memorandum describes the development and validation of a new, highly detailed, numerical model for simulating tides, storm surge, and waves in Penobscot Bay and vicinity.

In the first memorandum, we discussed how the NACCS study provides the climatological information and statistical framework necessary to estimate the probabilities associated with coastal flood hazards. The NACCS investigated the hazards using a suite of numerical models to simulate winds and atmospheric pressure, astronomical tides, storm surge, and wave conditions for a large number of coastal storm events, including historic extra-tropical storms (e.g.

northeasters), and synthetic tropical storms (e.g. hurricanes). The memorandum then describes how we identified a sub-set of storms that would be representative of the hazard for the Maine coast, and then obtained numerical model files from the USACE. We then compared the NACCS model water level results for the sub-set of historic storms to observation during those storms to evaluate the validity of the NACCS model. Through this validation effort we found that the NACCS model results had a negative bias in Penobscot Bay (i.e. on average they under predicted actual storm surge water levels), and that the bias was generally worse for more extreme storm events and for locations farther downeast. This negative bias suggests that the NACCS model results may underestimate the coastal flood hazard for Vinalhaven.

Our second memorandum prepared on August 17, 2017 documents how we developed and validated a new numerical model with detailed focus on Penobscot Bay using the same basic modeling techniques employed by the USACE in the NACCS.   This new model is able to use the output data from the larger scale NACCS model to provide the necessary boundary conditions for simulating tides, storm surge, and wave conditions for the sub-set of storms that characterize the coastal flood hazards for Penobscot Bay. The new "downscaled" model has considerably higher resolution and accuracy for Vinalhaven, and through further model validation efforts it was shown to provide better, unbiased, simulation of coastal flood hazards for the Penobscot bay area.

On August 30, 2017, Ransom provided two additional memoranda to the Town. The first presents and discuss local sea level rise projections for Vinalhaven, while the second memorandum describes the analysis of present and future flood hazard estimates that incorporate sea level rise projections, so that they may be used for effective future planning.

The local sea level rise memorandum presents a set of sea level rise scenarios that are based on recent guidance from the USACE and the National Oceanic Atmospheric Administration (NOAA). We then discuss some potential pitfalls with scenario-based sea level rise guidance, which stem from a lack of understanding of the likelihood of the various scenarios. We explain how scenario-based guidance, by itself, leaves planners and decision makers in a difficult and uncertain position, as they must decide what actions to take to mitigate future risks. We then explain how that can be remedied by considering recent probabilistic sea level rise guidance that quantifies the uncertainty in future projections. With scenario-based guidance alone, decision makers simply cannot know if they are too strongly considering a highly unlikely scenario, or conversely, not adequately considering a highly likely one. By considering the probabilistic guidance as well, they can better understand the likelihood of the different scenarios and how that likelihood may change with time.

Our present and future flood hazard memorandum starts out with some background information to familiarize the reader with basic hazard statistics. It then describes an analysis of the Penobscot Bay model results for extra-tropical storms to quantify the probabilities associated with extreme water levels and wave conditions[1]. The flood hazard information is then combined with

[1] It is noteworthy that this analysis did not include an analysis of the tropical storm simulations or pure tidal effects, and therefore, the hazard information may under estimate the likelihood of flooding associated with purely tidal events, or highly extreme tropical storm or hurricane impacts. We recommend that this analysis be updated in the future to include those analyses. In the meantime, the current analysis does provide reasonable estimates for the hazards associated with more or less frequent extra-tropical storm events like the storm that occurred on January 4, 2018. Therefore, the hazard information provided should

the probabilistic sea level rise guidance through a Monte Carlo technique to yield a series of hazard maps and flood hazard curves for present and future years. The resulting hazard information inherently includes increases in the hazards due to the full range of sea level rise scenarios, and therefore, this information can be used in future planning without the need to explicitly consider specific sea level rise scenarios.

To illustrate the Monte Carlo technique, a game called the Storm Surge Slot Machine (S3M) was developed and provided as an attachment. S3M can be used as an educational tool to help decision makers, stakeholders, and the general public understand how flood hazards are expected to increase in the future with sea level rise, and provide some basic hands-on understanding of the statistics used for assessing future hazards[2].

A set of flood hazard maps for Carvers Harbor, that show the water level and wave crest envelop hazard levels for 2017 and each future decade until 2117, were provided as hard copy and pdf files. Hazard maps, showing a greater range of hazard levels, and for each 5-year increment until 2117, were also provided to the Town in the KMZ format that can be viewed in Google Earth. After the hazard information was presented, we also provided the Town with discussion regarding the timing of the flood hazard and future increases in the likelihood of flooding for low areas of Main Street. We also provided some recommendations on how to use the hazard maps to identify vulnerable areas and assets, and next steps necessary to employ a risk informed decision making process, when evaluating future risk mitigation and sea level rise adaption options.

ADAPTATION OPTIONS AND RECOMMENDATIONS

Our analysis of present and future flood hazards for the Downstreet area in Vinalhaven is predicated on an understanding that problems with sea level rise will manifest through increasing flood hazards in the future. In other words, we consider sea level rise and coastal flooding hazards as inseparable processes, whose impacts are best understood through a framework that combines the randomness of flooding events with the uncertainty in future sea level rise. This allows us to estimate the probability of flooding today, and how that flooding probability will change in the future. Because flooding and sea level rise are essentially inseparable hazards, actions taken to adapt to sea level rise will go hand-in-hand with actions taken to mitigate present and future flood risks. Therefore, we recommend an adaptation approach that focuses on risk reduction and uses future hazard information as the basis for risk informed decision making.

During the course of our efforts, the Maine Coastal Program put forth a self-assessment tool for coastal communities to use to evaluate their vulnerability to flood hazards and community resilience[3]. This tool, called the “Maine Flood Resiliency Checklist”, was designed to help communities assess how well positioned they are to prepare for, respond to, and recover from flooding events, which will be exacerbated by sea level rise. It is also designed to help communities identify specific strategies to address their vulnerabilities. Now that this tool is

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be useful for planning studies that investigate options to prepare for similar events with future sea level rise.

[2] Ransom is currently working on an improvement to the S3M simulation game, which will replaces the cumbersome hazard curve plots developed with the roll of dice with game spinners to simplify the game play. We hope to present this improved version of the game on a poster at the 2018 Maine Water Conference in Augusta, Maine on March 28, 2018.

[3] http://digitalmaine.com/cgi/viewcontent.cgi?article=1520&context=mgs_publications

available, we strongly recommend that the Town utilize this tool. The effort described in this memorandum should allow the Town check off some important items, while the exercise of considering the other items in the checklist may help the Town identify additional opportunities for adaptation, beyond the recommendations given below.

Options for adaptation fall broadly within three categories: accommodate, protect, and retreat. Measures to mitigate risk may include traditional structural measures, such as fill and hardened seawalls, non-traditional natural and nature-based features, such as marsh creation, as well as non-structural interventions including policies, warning systems, risk education, etc. For Vinalhaven, it is likely that a combination of these features will provide the best overall benefit in terms of risk reduction and efficient use of limited resources. Thus, it is recommended that the Town consider a range of possible actions when planning for sea level change adaption. Adaptation planning should also be flexible and allow for evolution as guidance on sea level rise changes in the future and experience is gained with adaptation efforts.

Accommodate

Accommodation means essentially living with the change. Accommodation is already happening and any plan for sea level rise adaptation in Vinalhaven will almost certainly include some degree of accommodation in the near future, at least. Accommodation may include non-structural features. Possible non-structural measures include:

- Performing studies, such as this one, to better define flood hazard.
- Implementing local policies to reduce flood risk (e.g. participation in the FEMA National Flood Insurance Program (NFIP), and development and enforcement of floodplain management ordinances that are more stringent than required by the NFIP)[4].
- Development and implementation of early warning systems to inform stakeholders of impending flood events.
- Development and dissemination of educational tools to educate the public about their exposure to flood hazards, how those hazards are expected to increase in the future, and what may be done to mitigate risks associated with the increasing hazards.

For example, property owners could be informed of the likelihood of flooding on their property and be encourage to take action to accommodate that flooding. Such actions could include moving important items to higher floors in their buildings and elevating utilities, such as heating systems, fuel tanks, and electrical components, as they upgrade their utilities and/or perform renovations. A warning system could be developed and used to inform residents of an impending storm, and when they should take actions such as moving important building contents to higher

[4] Please note, FEMA flood maps only illustrate one particular hazard level in coastal zones (i.e. the 1% annual chance flood), and they do not indicate how that hazard will change with future sea level rise. For this reason, we recommend that any educational tools developed for the general public make this fact clear, and provide the public with information on the full spectrum of present and future flood hazards, such as the combined sea level rise and coastal flood hazard information generated through this effort

floor. Considering the timing of future hazards, accommodation might be a reasonable option for adaptation for the next 20 to 30 years or so, until the likelihood of moderate to severe flooding becomes too great.

<u>Protect</u>

Protection typically involves some type of structural measure to maintain current function in the face of rising sea levels and increasing flood hazards. This may include traditional structural measures, such as elevating roadways and buildings, filling wharves to higher elevations, constructing seawalls, bulkheads, and revetments, installing flood gates, etc. It may also include the use of natural or nature-based features such as man-made marshes to reduce wave energy. Possible protection actions for Vinalhaven may consider the following:

- *Elevating Low Lying Areas of Main Street.* We understand that the Town is planning for near term improvements to sidewalks in the area. As a synergistic addition to that effort, we recommend the Town also undertake a study to assess the feasibility of elevating the roadway as well. The feasibility study would consider a variety of alternatives for making improvements to the roadway, estimate the cost of implementing those alternatives, and weigh the costs against the benefits associated with reduced flood risk in the area to determine if such actions are feasible. Different alternatives would likely include a range of target elevations for the minimum road elevation. Greater elevation would provide greater benefit, but also require greater costs. The flood hazard information developed through this effort could be used to assess the benefits of raising the roadway for a range of elevations.

  Meanwhile, additional effort would be required to assess the costs associated with construction and potential limitations on the roadway heights. For example, the height may be limited by curb heights and the threshold elevations of existing buildings. Other limitations that must be considered include the presence of underground utilities, geotechnical considerations related to the porous fill on which parts of the road have been built, and hydraulic considerations related to the sluiceway and bridge over the Carvers Pond inlet. Although available Light Detection and Ranging (LiDAR) data could be used to identify limits to the area of study, the feasibility study should also include a topographic survey of the area to provide greater detail and accuracy than can be provided by LiDAR alone.

- *Elevating Buildings on Main Street.* There are numerous buildings along Main Street that are located within the floodplain. Raising the elevation of these buildings is another action that could be taken to reduce flooding risks. We understand that most of these structures are privately owned, and therefore, the responsibility for any building improvements, such as increasing the elevation of the structure, will fall on the individual property owner. Because entryway thresholds likely limit the feasibility of the roadway elevation, we recommend the Town encourage property owners to consider the costs and benefits of elevating their buildings.

  The benefits of building elevation, in terms of reduced risk can be estimated using the hazard information derived through this effort, along with an appropriate depth-damage function for the building, as described in our August 30, 2017 memorandum of present and future flood hazards. Although depth-damage functions are available for general structure types, property owners may be best served by evaluating the specific consequences of flooding of their property and developing their own unique depth-damage function.

Another highly tangible benefit of elevating buildings can be recognized through reduced flood insurance costs for properties that are insured through the NFIP and/or private flood insurance. Property owners can contact their insurance agent to get estimates of these benefits. Property owners who purchase insurance through the NFIP should be aware that NFIP claims are limited and may not cover the full cost of damages to their property after a flood. Therefore, when assessing the benefits of raising their building, they should also take into account the cost of risk beyond what is covered by the NFIP insurance.

Assessing the cost of building elevation depends on the type of structure, where it is located, the type of existing foundation, etc. As such, property owners will be best served if they estimate the unique cost associated with elevation of their unique building. Construction contractors who specialize in repairing foundations and/or elevating buildings may be able to provide estimates of those costs.

- *Installing a Tide Gate at the Carvers Pond Inlet.* The inlet to Carvers Pond at the head of Carvers Harbor has a long history of modifications to capture tidal energy for beneficial uses. Another possible option, which could provide flood protection to properties subject to flooding from Carver's Pond would be to install a tide gate structure at the inlet, which would limit the potential for flooding in the pond. This presents a unique and interesting opportunity for the Town to highlight the historic use of the site, while also addressing modern issues related to flood risk management and the burgeoning interest around carbon free alternative energy sources. We recommend the Town consider the feasibility of this option in greater detail. This would require considerable study to better understand the hydraulics of the inlet and any possible environmental impacts from its modification. Any proposed plans to modify the inlet and install hydraulic controls would also need to consider plans for elevating Main Street and would likely require modifications to the foundation of the Tidewater Inn, which could include elevation of the structure to reduce flood risk. Any potential modifications to the Carver's pond inlet should take a long-term view of sea level change in their design, as they are likely to remain in place for a century or more, as the present hydraulic structures have.

- *Planning and Modification at the Ferry Terminal.* We understand the Town is concerned about potential sea level rise and flooding impacts to the Ferry terminal. Due to its location within the harbor and the need for boat access. It is probably unfeasible to install flood gates or similar structures that could limit high water elevations at the terminal. However, although waves are significantly attenuated by the natural setting of the harbor before they reach the Ferry Terminal, our analysis has shown that wave impacts at the Ferry terminal could be significant during an extreme storm event, and these impacts will become greater in magnitude and possibly more frequent with sea level rise. We recommend the Town consider the susceptibility of Ferry Terminal infrastructure to damages from wave run-up and overtopping, as well flooding by an extremely high tide. Such a study would require a detailed survey of the infrastructure and a vulnerability assessment to identify what is at risk. If it is found that the risk due to wave attack is considerable, it is possible that a breakwater could be used to reduce the wave energy that reaches the terminal during extreme storms. The cost of designing, permitting, and constructing a breakwater would be significant, so this may not be a feasible option if the structures onshore at the terminal can be more easily hardened to withstand significant wave attack.

Please note, large damaging waves depend primarily on offshore wind conditions and can occur at any water level, regardless of the sea level rise. It is possible that climate change may lead to more frequent occurrence of damaging wave events, but this has not been investigated in the present study. It is also possible that climate change could lead to less frequent occurrence of extreme wave events, but when coupled with sea level rise, the events that do occur will be more extreme.

With regards to the Ferry terminal, we also understand there can be difficulty moving vehicles on or off the Ferry during times of extremely high water, due to the angle the vehicle ramp makes with the car deck on the Ferry. As sea levels rise, this is will become a more common occurrence. This problem can be remedied through structural modifications to the terminal, or by possibly adjusting the ferry schedule as required. Structural remedies are likely to be more costly, whereas the need to adjust the schedule (or suffer delays) will increase in frequency with sea level rise. To better understand this impact on the Ferry Terminal, we recommend the Town undertake a simple study to evaluate the cost of such modifications, and evaluate the future timing of problematic high tides. The study would require an elevation survey to identify critical water levels above which the Ferry is inaccessible to vehicles, and a tide study to determine tidal harmonics for the Ferry location. Because astronomic tides are highly predictable, this information could be combined with the sea level rise information to estimate future times when the Ferry would most likely be inaccessible. Comparing this information to the Ferry schedule would allow for an assessment of the impact. We expect that in the near-term problematic tides would be relatively infrequent and could be dealt with by adjusting the ferry schedule or allowing for delays, but in the long-term the problem may become frequent enough to warrant structural modification to the terminal. The recommended study would help the town identify when such modifications would become feasible.

<u>Retreat</u>

In the long term, it is possible that sea level rise will cause some properties to be inundated daily, under normal tidal conditions. Because of the large degree of uncertainty in long-term sea level rise projections, we cannot determine precisely when this will happen. We must also consider that it is more likely that a structure subject to this type of flooding would be damaged by one or more storm events before sea level has risen enough for this concern to play out. Retreat may be a viable option for such properties, because the cost associated with damages and/or insurance requirements may soon outweigh the value of the property. Evaluation of the feasibility of elevating buildings, as recommended above, should consider retreat as a possible option.

With the information developed in this effort we can only estimate the probability of flooding in a given future year. For example, as described in our August 30, 2017 memorandum on present and future flood hazards, areas around Downstreet that are presently below an elevation of 9 feet (NAVD88) have about a 1-in-30 annual chance of being inundated in 2017, but that chance will increase to about 1-in-10 by 2057, and by 2117, it will become a nearly certain daily occurrence. If long-term plans are not implemented to protect these areas, so that they can accommodate daily flooding, as well as flooding from more extreme events, the best approach may be to remove structures from these areas (i.e., retreat) and manage the progression of the properties toward a more natural state through the construction of natural or nature-based features, such as a constructed marshes.

For the most part, due to the economic viability of the Downstreet shorefront, retreat will probably not be the preferred option for most properties. However, it should still be considered as an option, particularly for residential properties and/or older lower value properties that are located on the harbor side of Main Street, where the risk of flooding is greatest.

SUMMARY OF RECOMMENDATIONS

- Complete the Maine Flood Resilience Checklist.
- Update hazard information to include possible impacts from tropical storms and hurricanes, and purely tidal events.
- Evaluate the feasibility of elevating low-lying areas of Main Street.
- Provide property owners with educational tools and resources to evaluate the feasibility of elevating their buildings. Consider retreat as a possible option in certain cases, especially for residential buildings and/or properties with low value.
- Evaluate the feasibility of installing a flood gate at the Carvers Pond inlet.
- Evaluate the vulnerability of Ferry Terminal infrastructure to extreme wave impacts, and consider construction of a breakwater.
- Evaluate the timing when vehicle access to the Ferry boat will be difficult.
- Allow planning to be flexible and evolve with new information and experiences.

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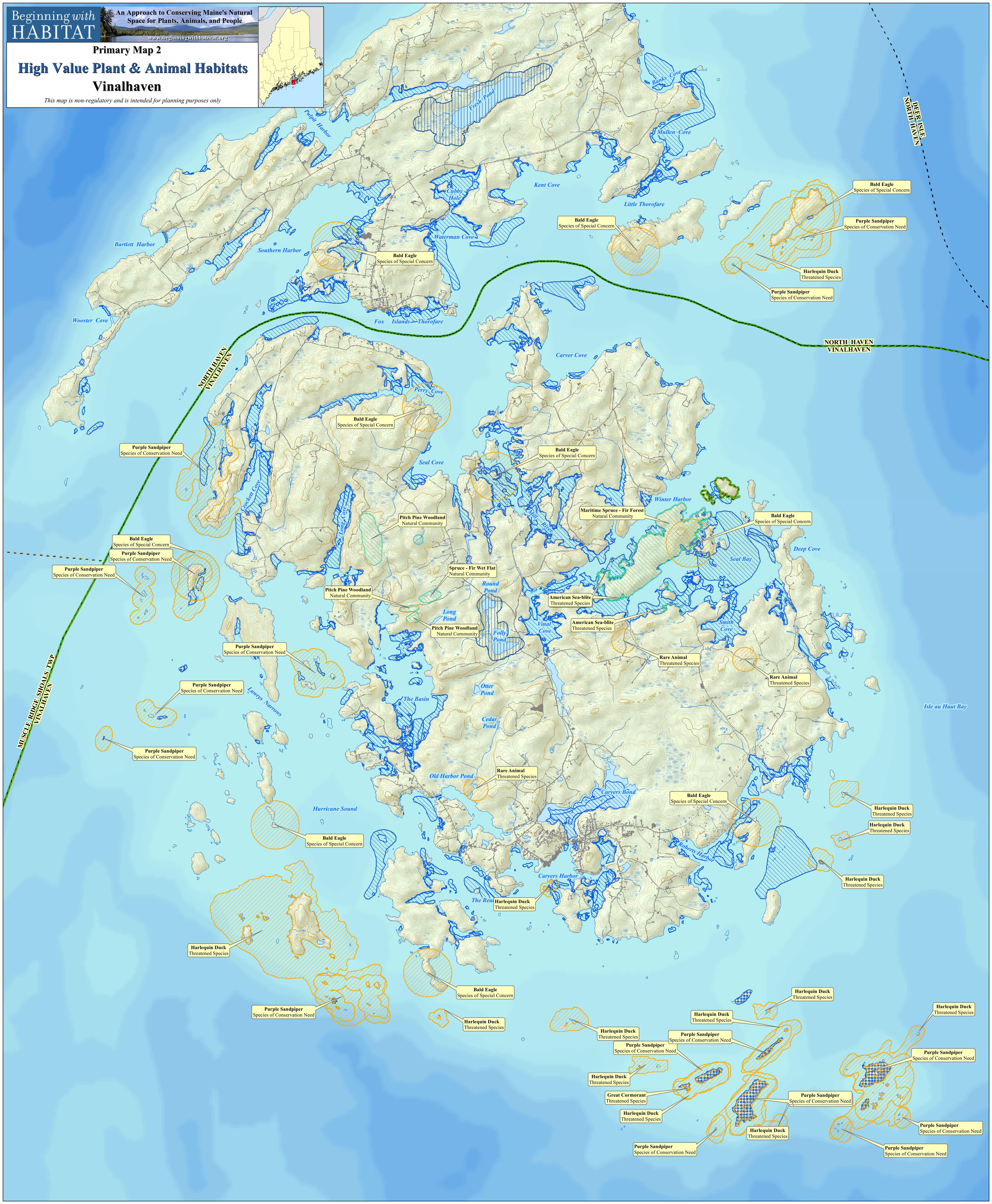
Primary Map 2

High Value Plant & Animal Habitats

Vinalhaven

This map is non-regulatory and is intended for planning purposes only



Feet 5,000 2,500 0 0.5 1 Miles

Meters 1,000 500 0 0.5 1 Kilometers

1:24,000 Scale
Projection: UTM 19N
Datum: NAD 1983

LEGEND

Beginning with Habitat (BwH) is a voluntary tool intended to assist landowners, resource managers, planners, and municipalities in identifying and making informed decisions about areas of potential natural resource concern. This data includes the best available information provided through BwH's coalition partners as of the map date, and is intended for information purposes only. It should not be interpreted as a comprehensive analysis of plant and animal occurrences or other local resources, but rather as an initial screen to flag areas where agency consultation may be appropriate. Habitat data sets are updated continuously as more accurate and current data becomes available. However, as many areas have not been completely surveyed, features may be present that are not yet mapped, and the boundaries of some depicted features may need to be revised. Local knowledge is critical in providing accurate data. If errors are noted in the current depiction of resources, please contact our office. Some habitat features depicted on this map are regulated by the State of Maine through the Maine Endangered Species Act (Essential Habitats and threatened and endangered species occurrences) and Natural Resources Protection Act (Significant Wildlife Habitat). We recommend consultation with MDIFW Regional Biologists or MNAP Ecologists if activities are proposed within resource areas depicted on this map. Consultation early in the planning process usually helps to resolve regulatory concerns and minimize agency review time. For MDIFW and MNAP contact information, visit http://www.beginningwithhabitat.org/contacts/index.html.

Organized Township Boundary

Unorganized Township

Selected Town or Area of Interest

Developed: Impervious surfaces such as buildings and roads

Rare, Threatened, or Endangered Wildlife

Known rare, threatened, or endangered species occurrence and/or the associated habitats based on species sightings.

Consult with an MDIFW regional biologist to determine the relative importance and conservation needs of the specific location and supporting habitat. The names of some speices have been masked with a "Rare Animal" designation on the map for further protection. For more information regarding individual species visit our website, http://www.maine.gov/ifw/wildlife/endangered/listed_species_me.htm, for species specific fact sheets.

The Federal Endangered Species Act requires actions authorized, funded, or carried out by federal agancies be reviewed by the U. S. Fish and Wildlife Service. If your project occurs near an occurrence of the Atlantic Salmon, Roseate Tern, Piping Plover, Canada Lynx, New England Cottontail, Fubish's Lousewort, or Small-whorled Pagonia contact the Maine Field Office, USFWS, 1168 Main St., Old Town, ME 04468.

Rare or Exemplary Plants and Natural Communities

Rare Plant Locations

Known rare, threatened, or endangered plant occurrences are based on field observations. The names of some speices have been masked with a "Rare Plant" designation on the map for further protection. Consult with a Maine Natural Areas Program (MNAP) Ecologist to determine conservation needs of particular species. For more information regarding rare plants the complete list of tracked species and fact sheets for those species can be found at: http://www.maine.gov/doc/nrimc/mnap/features/plantlist.htm

Rare or Exemplary Natural Community Locations

The MNAP has classified and distinguished 98 different natural community types that collectively cover the state's landscape. These include such habitats as floodplain forests, coastal bogs, alpine summits, and many others. Each type is assigned a rarity rank of 1 (rare) through 5 (common). Mapped rare natural communities or ecosystems, or exemplary examples of common natural communities or ecosystems, are based on field surveys and aerial photo interpretation. Consult with an MNAP Ecologist to determine conservation needs of particular communities or ecosystems.

Essential Wildlife Habitats

Roseate Tern Nesting Area *or*
Piping Plover-Least Tern Nesting, Feeding, & Brood-Rearing Area

Maine's Department of Inland Fisheries & Wildlife (MDIFW, www.state.me.us/ifw) maps areas currently or historically providing habitat essential to the conservation of endangered or threatened species as directed by the Maine Endangered Species Act (12 MRSA, Chapter 925, Subchapter 3, Sections 12804 and 12806) and regulations (MDIFW Rules, Chapter 8.05). Identification of Essential Habitat areas is based on species observations and confirmed habitat use. If a project occurs partly or wholly within an Essential Habitat, it must be evaluated by MDIFW before state and/or municipal permits can be approved or project activities can take place.

Significant Wildlife Habitats

Candidate Deer Wintering Area

Forested area possibly used by deer for shelter during periods of deep snow and cold temperatures. Assessing the current value of a deer wintering area requires on-site investigation and verification by IF&W staff. Locations depicted should be considered as approximate only.

Inland Waterfowl / Wading Bird

Freshwater breeding, migration/staging, and wintering habitats for inland waterfowl or breeding, feeding, loafing, migration, or roosting habitats for inland wading birds.

Seabird Nesting Island

An island, ledge, or portion thereof in tidal waters with documented, nesting seabirds or suitable nesting habitat for endangered seabirds.

Shorebird Areas

Coastal staging areas that provide feeding habitat like tidal mud flats or roosting habitat like gravel bars or sand spits for migrating shorebirds

Tidal Waterfowl / Wading Bird

Breeding, migrating/staging, or wintering areas for coastal waterfowl or breeding, feeding, loafing, migrating, or roosting areas for coastal wading birds. Tidal Waterfowl/Wading Bird habitats include aquatic beds, eelgrass, emergent wetlands, mudflats, seaweed communities, and reefs.

Significant Vernal Pools

A pool depression used for breeding by amphibians and other indicator species and that portion of the critical terrestrial habitat within 250 ft of the spring or fall high water mark. A vernal pool must have the following characteristics: natural origin, nonpermanent hydroperiod, lack permanently flowing inlet or outlet, and lack predatory fish.

Maine's Natural Resources Protection Act

Maine's Natural Resources Protection Act (NRPA, 1988) is administered by the Maine Department of Environmental Protection (MDEP; http://www.maine.gov/dep/blwq/docstand/nrpapage.htm) and is intended to prevent further degradation and loss of natural resources in the state, including the above Significant Wildlife Habitats that have been mapped by MDIFW. MDEP has regulatory authority over most Significant Wildlife Habitat types. The regional MDEP office should be consulted when considering a project in these areas.

Atlantic Salmon Spawning/Rearing Habitat

Atlantic Salmon Rearing Habitat

Atlantic Salmon Spawning Habitat

Atlantic Salmon Limited Spawning Habitat

Mapped by Atlantic Salmon Commission (ASC) and US Fish & Wildlife Service (USFWS) from field surveys on selected Penobscot and Kennebec River tributaries and the Dennys, Ducktrap, East Machias, Machias, Pleasant, Narraguagus, and Sheepscot Rivers.

Data Sources

DATA SOURCE INFORMATION

TOWNSHIP BOUNDARIES
Maine Office of GIS: *Metwp24* (2013)
ROADS
Maine Office of GIS, Maine Department of Transportation: *Medotpub* (2015)
HYDROLOGY
U.S. Geological Survey National Hydrography Dataset (NHD) Maine (2012)
DEVELOPED
Maine Office of GIS, Maine Department of Inland Fisheries and Wildlife, and multiple other agencies: *Imperv* (2015)
ESSENTIAL & SIGNIFICANT WILDLIFE HABITATS
Maine Office of GIS, Maine Department of Inland Fisheries & Wildlife; *DWA, ETSC, Ehplvtrn, Ehrtern, IWWH, Sni, Shorebird, TWWH* (2003-2015)
RARE NATURAL COMMUNITIES & PLANTS
Maine Natural Areas Program: *MNAP_eos* (2015)
ATLANTIC SALMON HABITAT
Maine Office of GIS, Maine Atlantic Salmon Commission, U.S. Fish & Wildlife Service: *Ashab3* (2013)

DATA SOURCE CONTACT INFORMATION

Maine Office of GIS: http://www.maine.gov/megis/catalog/
Maine Natural Areas Program: http://www.maine.gov/dacf/mnap/index.html
Maine Department of Inland Fisheries & Wildlife: http://www.maine.gov/ifw/
U.S. Fish & Wildlife Service, Gulf of Maine Program: http://gulfofmaine.fws.gov
Maine Atlantic Salmon Commission: http://www.maine.gov/asc/
Maine Department of Transportation: http://www.maine.gov/mdot/

DIGITAL DATA REQUEST

To request digital data for a town or organization, please visit our website.
http://www.beginningwithhabitat.org/the_maps/gis_data_request.html

Supported in part by Maine Outdoor Heritage Fund lottery ticket sales

Map Prepared by Maine Department of Inland Fisheries & Wildlife

July 2018

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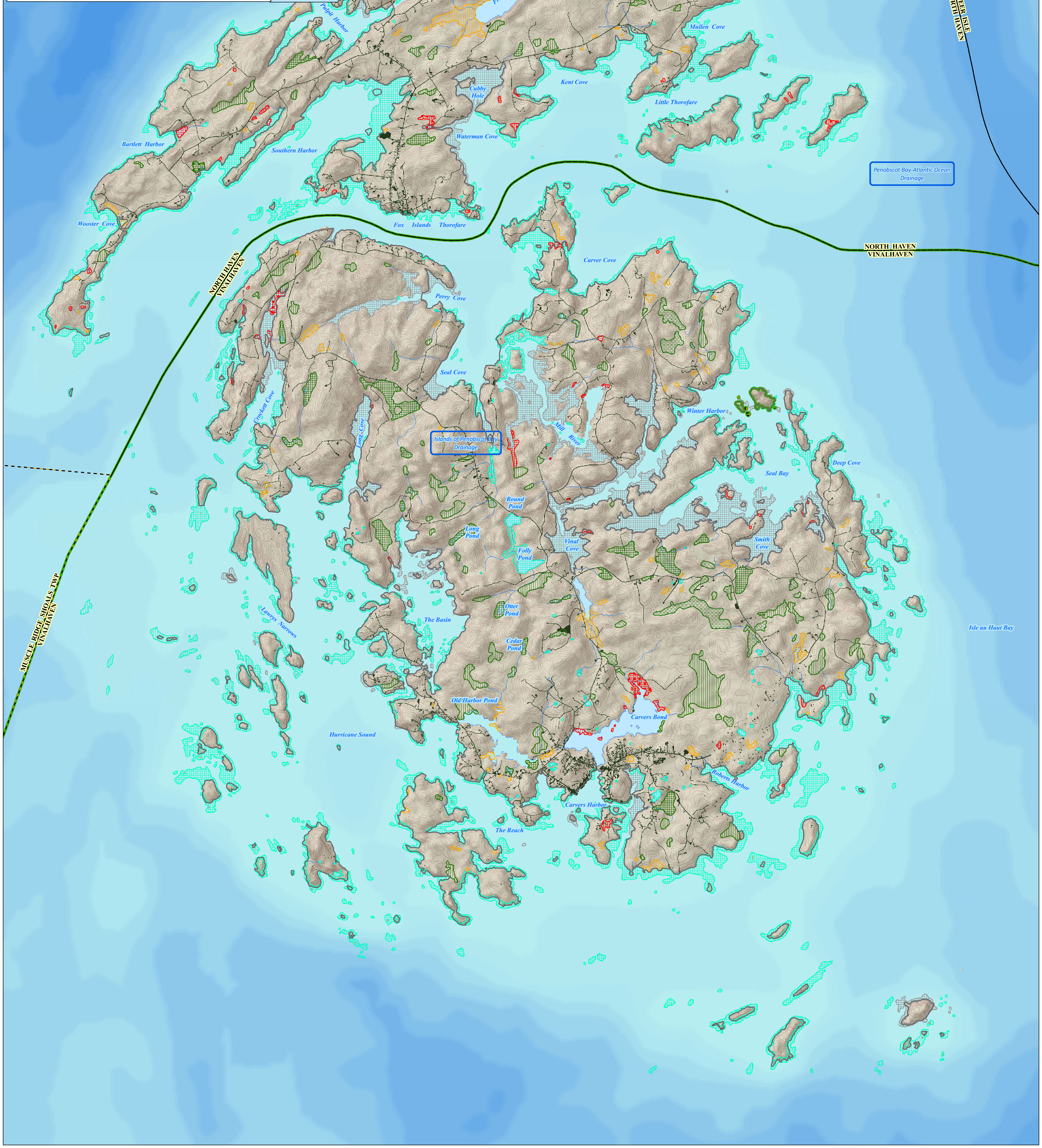
Supplementary Map 7

Wetlands Characterization

Vinalhaven

This map is non-regulatory and is intended for planning purposes only



LEGEND

This map depicts all wetlands shown on National Wetland Inventory (NWI) maps, but categorized them based on a subset of wetland functions. This map and its depiction of wetland features neither substitute for nor eliminate the need to perform on-the-ground wetland delineation and functional assessment. In no way shall use of this map diminish or alter the regulatory protection that all wetlands are accorded under applicable State and Federal laws. For more information about wetlands characterization, contact Elizabeth Hertz at the Maine Department of Conservation (207-287-8061, elizabeth.hertz@maine.gov).

The Wetlands Characterization model is a planning tool intended to help identify likely wetland functions associated with significant wetland resources and adjacent uplands. Using GIS analysis, this map provides basic information regarding what ecological services various wetlands are likely to provide. These ecological services, each of which has associated economic benefits, include: floodflow control, sediment retention, finfish habitat, and/or shellfish habitat. There are other important wetland functions and values not depicted in this map. Refer to www.maine.gov/dep/water/wetlands/ipwetfv2.html for additional information regarding wetland functions and values. Forested wetlands and small wetlands such as vernal pools are known to be underrepresented in the National Wetlands Inventory (NWI) data used to create this map. The model developed to estimate the functions provided by each wetland could not capture every wetland function or value. Therefore, it is important to use local knowledge and other data sources when evaluating wetlands, and each wetland should be considered relative to the whole landscape/watershed when assessing wetland resources at a local level.

Organized Township Boundary

Unorganized Township

Selected Town or Area of Interest

Developed: Impervious surfaces including buildings and roads

Subwatersheds- The shaded, background polygons are subwatersheds (areas that drain to a particular lake, wetland, pond, river, stream, or the ocean). The subwatersheds are shaded to show topographic relief. This "hillshading" assumes the sun is shining from the northwest, so ridgetops and northwest-facing slopes appear light, whereas valleys and southeast-facing slopes appear dark. Because many areas of Maine are relatively flat, the topographic relief shown here has been exaggerated to make the details easier to see.

Wetland Functions: Fill Pattern

Some wetlands may have more than one funtion (fill pattern)

RUNOFF / FLOODFLOW ALTERATION
Wetlands provide natural stormwater control capabilities. As natural basins in the landscape, wetlands are able to receive, detain, and slowly release stormwater runoff. Wetland shelves along stream banks naturally regulate flood waters by providing an area for swollen stream flows to expand and slow, thereby protecting downstream properties. This map assigns Runoff/Floodflow Alteration Functions to wetlands that are (a) contained in a known flood zone, (b) associated with a surfacewater course or waterbody, and (c) with slope < 3%.

AND/OR

EROSION CONTROL / SEDIMENT RETENTION
Wetlands act as natural sponges that can hold water, allowing suspended particles such as sediment to settle out. The dense vegetation in most wetlands helps to stabilize soil and slow water flows, thereby reducing scouring and bank erosion. This map assigns Erosion Control / Sediment Retention functions to wetlands with (a) slope < 3%; (b) emergent vegetation; and (c) close proximity to a river, stream, or lake.

FINFISH HABITAT
Wetlands with documented finfish populations, including wetlands adjacent to a river, stream, or lake.

AND/OR

SHELLFISH HABITAT
Inland wetlands and streams can directly affect the status of coastal shellfish harvest areas. Fecal coliform bacteria and waterborne nutrients resulting from land use changes away from the coast can travel via surface water to harvestable flats. One failed septic system near a stream could close a mudflat several miles away. Excessive nutrients can reduce water clarity and stimulate epiphytic growth that degrades eelgrass meadows. Conservation of freshwater wetlands and stream buffers in coastal watersheds is a key component in marine resource conservation. This map assigns a Shellfish Habitat function to wetlands within 0.5 miles of (a) identified shellfish habitat, (b) identified shellfish closure areas, or (c) mapped eelgrass beds OR palustrine wetlands directly connected by a stream of < 0.5 mile in length to (a) identified shellfish habitat, (b) identified shellfish closure areas, or (c) mapped eelgrass beds.

PLANT/ANIMAL HABITAT
Nearly all wildlife species, and many of Maine's plant species, depend on wetlands during some part of their life cycle. For the purposes of this map, wetlands containing open water or emergent vegetation, 3 or more wetland vegetation classes (see below), and within ¼ mile of a known rare, threatened, or endangered plant or animal occurrence, within ¼ mile of a mapped significant or essential habitat, or within ¼ mile of a rare or exemplary natural community have been assigned this function. Rare element occurrences and mapped habitats can be found on Map 2 High Value Plant & Animal Habitats.

OTHER FUNCTIONS
CULTURAL/EDUCATIONAL. Wetlands within ¼ mile of a boat ramp or school have been assigned this value as these wetlands are likely candidates for use as outdoor classrooms, or similar social benefit. Wetlands rated for other functions listed above may also demonstrate cultural/educational values although not expressly shown.

OR

NO DOCUMENTED FUNCTION. The basis of this characterization is high altitude aerial photos. Photo quality often limits the information that can be interpreted from small wetland features, or those with dense canopy cover. Although not assigned a function under this study, ground surveys may reveal that these wetlands have multiple functions and values.

Wetland Class: Fill Color

Aquatic Bed (floating or submerged aquatic vegetation), Open Water

Emergent (herbaceous vegetation), Emergent/Forested Mix (woody vegetation >20 ft tall), Emergent/Shrub-Scrub Mix (woody vegetation <20 ft tall)

Forested, Forested/Shrub-scrub

Shrub-scrub

Other (rocky shore, streambed, unconsolidated shore, reef, rocky bottom)

National Wetlands Inventory (NWI) maps (the basis of wetlands shown on this map) are interpreted from high altitude photographs. NWI Wetlands are identified by vegetation, hydrology, and geography in accordance with "Classification of Wetlands and Deepwater Habitats" (FWS/OBS-79/31, Dec 1979). The aerial photographs document conditions for the year they were taken. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, State, or local government. NWI maps depict general wetland locations, boundaries, and characteristics. They are not a substitute for on-ground, site-specific wetland delineation.

Data Sources

DATA SOURCE INFORMATION
(note: italicized file names can be downloaded from Maine Office of GIS)
TOWNSHIP BOUNDARIES
Maine Office of GIS (2015); *metwp24*
ROADS
Maine Office of GIS, Maine Department of Transportation (2015); *medotpub*
HYDROLOGY
Maine Office of GIS, U.S. Geological Survey (2010); *NHD*
DEVELOPED
Maine Office of GIS, Maine Department of Inland Fisheries and Wildlife (2015)
NATIONAL WETLANDS INVENTORY (NWI)
Maine Office of GIS (2015); *NWI*
DRAINAGE DIVIDES
Maine Office of GIS (2015); *medrdvd*

DATA SOURCE CONTACT INFORMATION
Maine Office of GIS: http://www.maine.gov/megis/
Maine Department of Transportation: http://www.maine.gov/mdot/
Maine Department of Agriculture, Conservation and Forestry:
http://www.maine.gov/dacf/planning/index.html
Maine Geological Survey: http://www.maine.gov/doc/nrimc/mgs/mgs.htm

DIGITAL DATA REQUEST
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Feet 5,000 2,500 0 0.5 1 Miles
Meters 1,000 500 0 0.5 1 Kilometers

Scale: 1:24,000
Projection: UTM 19N
Datum: NAD 1983

Supported in part by Maine Outdoor Heritage Fund lottery ticket sales

Map Prepared by Maine Department of Inland Fisheries & Wildlife
July 2018

Supported in part by Loon Conservation Plate funds

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Supplementary Map

Natural Resource Co-occurrence

Vinalhaven

This map is non-regulatory and is intended for planning purposes only

Legend

This map represents the concentration of selected environmental asset data layers overlaid on the landscape. Its purpose is to highlight a given area's relative conservation values as an aid in planning. It offers a generalized and subjective view and should be considered as a starting point for discussion. The layers on this map include buffer zones around water features, important natural communities, listed plant and animal species, areas of undeveloped land, and conserved properties. Some of these layer attributes have been weighted based on qualitative features, such as rarity or size, and are noted below. Cooccurrence modeling is extremely flexible, allowing for the addition, substitution, and relative weighting of data and attributes that best reflect the particularities and priorities of a given area or community. This map draws on data that is depicted on the standard Beginning with Habitat map set, but should still be considered as both supplementary and as work in development.

Organized Township Boundary

Unorganized Township

Selected Town or Area of Interest

Developed: Impervious surfaces such as buildings and roads

Conservation Land

Selected Resource Layers and Assigned Values

Geographic Information System (GIS) software provides a ready means to help identify areas of high resource cooccurrence. The selected data layers of interest are assigned a relative weight, or value, and then overlaid on one another. The values are then summed, classified, and symbolized, revealing the concentration of attributes in a given landscape. (Some of the layers listed may not apply to, or be present on, the area represented by this map.)

Rare and Exemplary Natural Communities
- S1 (Critically Imperiled). Value of 4
- S2 (Imperiled). Value of 4
- S3 (Rare). Value of 3
- S4 and S5 with A or B viability (Exemplary). Value of 3

Rare Plants
- S1 (Endangered). Value of 3
- S1S2 - S2 (Threatened). Value of 2
- S2S3 - S3 (Special Concern). Value of 1

Listed Animals
- Endangered Species (with buffer). Value of 3
- Threatened Species (with buffer). Value of 2
- Species of Special Concern (with buffer). Value of 1

Significant Wildlife Habitats
- Shorebird Habitat. Value of 3
- Seabird Nesting Islands. Value of 3
- Essential Wildlife Habitat. Value of 3
- Wading Bird and Waterfowl Habitats (inland and tidal). Value of 2
- Deer Wintering Areas. Value of 1
- Significant Vernal Pools (with 500' buffer). Value of 1
- Atlantic Salmon Habitat. Value of 2
- Heritage BrookTrout Waters. Value of 2
- Shellfish Beds. Value of 1

Riparian Zones and Water Resources
- Tidal waters 250' buffer. Value of 2
- Great Ponds 250' buffer. Value of 1
- Rivers 250' buffer. Value of 1
- Streams 75' buffer. Value of 1
- Wetlands greater than 10 acres plus 250' buffer. Value of 1
- Wetlands less than10 acres plus75' buffer. Value of 1
- Groundwater Aquifers. Value of 1

Undeveloped Habitat Blocks
- Areas over 1200 acres. Value of 3
- Areas of 600 to 1200 acres. Value of 2
- Areas of 200 to 600 acres. Value of 1

Sum of Attribute Values

0

1-2

3

4-5

6-8

9-12

Over 12

Focus Areas

Focus Areas of Statewide Ecological Significance
(note: not present in all regions)

Focus Areas of Statewide Ecological Significance have been designated based on an unusually rich convergence of rare plant and animal occurrences, high value habitat, and relatively intact natural landscapes (the combined elements of Beginning with Habitat Maps 1-3). Focus area boundaries were drawn by MNAP and MDIFW biologists, generally following drainage divides and/or major fragmenting features such as roads. Focus Areas are intended to draw attention to these truly special places in hopes of building awareness and garnering support for land conservation by landowners, municipalities, and local land trusts. For descriptions of specific Focus Areas, consult the Beginning with Habitat notebook or the following website: http://www.maine.gov/dacf/mnap/focusarea/index.htm

Data and Information Sources

DATA SOURCES

TOWNSHIP BOUNDARIES
Maine Office of GIS: *Metwp24* (2013)
ROADS
Maine Office of GIS, Maine Department of Transportation: *Medotpub* (2015)
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Maine Office of GIS, Maine Department of Inland Fisheries & Wildlife; *DWA, ETSC, Ehplvtrn, Ehrtern, IWWH, Sni, Shorebird, TWWH* (2003-2015)
RARE NATURAL COMMUNITIES & PLANTS
Maine Natural Areas Program: *MNAP_eos* (2015)
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Maine Office of GIS, Maine Atlantic Salmon Commission, U.S. Fish & Wildlife Service: *Ashab3* (2013)

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Maine Natural Areas Program: http://www.maine.gov/dacf/mnap/index.html
Maine Department of Inland Fisheries & Wildlife: http://www.maine.gov/ifw/
U.S. Fish & Wildlife Service, Gulf of Maine Program: http://gulfofmaine.fws.gov
Maine Atlantic Salmon Commission: http://www.maine.gov/asc/
Maine Department of Transportation: http://www.maine.gov/mdot/

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State of Maine

Feet 5,000 2,500 0 0.5 1 Miles

Meters 1,000 500 0 0.5 1 Kilometers

1:24,000 Scale
Universal Transverse Mercator (UTM) Projection
North American Datum (NAD) 1983

Supported in part by Maine Outdoor Heritage Fund lottery ticket sales

Map Prepared by Maine Department of Inland Fisheries & Wildlife
July 2018

Supported in part by Loon Conservation Plate funds

Vinalhaven CoF Worksheet

Category		Consequence of Failure Score			
		Health & Safety	Community Service	Financial	Environmental Damage
		5. Significant Risk of Injury or Death 4. Significant risk of major injury or health impact 3. Low risk of major injury or health impact 2. Low risk of injury or health impact 1. No Risk of Injury or health impact	5. Major service interruption, reputation impact and/or national media coverage. 4. Intermittent services, reputation impact and local or regional media attention. 3. Minor service and reputation impacts, no media. 2. No Media and reputation impacts, minor intermittent service impacts. 1. No media, reputation or reputation impacts.	5. Greater than $1 million 4. $100k to $500k 3. $50k to $100k 2. $10,000 to $50k 1. Less than $10,000 * Used industry knowledge of infrastructure/equipment costs.	5. Significant environmental damages. 4. Localized environmental damage. 3. Possible environmental damage. 2. Possible Minor or eventual environmental damage. 1. No environmental damage

Name of Critical Asset*	Comments	Health and Safety Score	Community Image	Financial Score	Environmental Damage Score	Average Value
Wastewater Treatment Facility	Holds the UV disinfection system, laboratory, restroom and the electrical and controls equipment for the WWTF.	4	4	5	4	4.25
Gravity Mains	The collection system is mostly gravity mains.	3	3	4	3	3.25
Force Mains		3	3	3	3	3
West Main Street (Fire Station) Pump Station	Has a pump capacity of 300 GPM. Serves 230 users including single family, commercial, industrial and municipal.	3	4	4	4	3.75
Atlantic Avenue (Lanes Island) Pump Station	Has a pumping capacity of 175 GPM. Serves 23 residential and commercial users.	3	3	3	4	3.25
High Street Pump Station	Has a pumping capacity of 175 GPM. Serves 32 residential and commercial customers.	3	3	3	3	3
Indian Creek Pump Station	Has a pumping capacity of 150 GPM. Serves 31 residential and commercial users.	2	3	3	3	2.75
Sands Road Pump Station	Has a pumping capacity of 400 GPM. Serves 90 residential and commercial users.	3	3	4	3	3.25
Main Street Pump Station	Has a pumping capacity of 300 GPM. Serves 260 residential and municipal users.	3	4	4	4	3.75
Leo's Lane Pump Station	Has a pumping capacity of 150 GPM. Serves 35 residential, commercial and municipal users.	2	3	3	4	3
Chestnut Street Pump Station	Has a pumping capacity of 150 GPM. Serves 12 single family home users.	2	3	3	3	2.75
School Street Pump Station	Has a pumping capacity of 125 GPM. Serves 57 residential and commercial users.	2	3	3	3	2.75

Likelihood of Failure Scoring Criteria

		Weight	5	4	3	2	1
Sea Level Rise*	Maine Geological Survey data indicated the potential extent of sea level rise under various emission scenarios along the Maine coast on top of Highest Astronomical Tide. This dataset indicates the potential inland extent of inundation from several scenarios (1.2, 1.6, 3.9, 6.1, 8.8 and 10.9 feet) of sea level rise or storm surge along the Maine coastline on top of the Highest Astronomical Tide. Vinalhaven's wastewater system assets were scored based on whether they fell into a Sea Level Rise zone and the extent of inundation of that zone.	25%	1.2	1.6	3.9	6.1	10.9
SLOSH Zone**	Maine Geological Survey prepared Sea Lake and Overland Surges from Hurricanes (SLOSH) maps to be used for planning purposes. The data indicated areas along the coastline that may be inundated by a Category 1, 2, 3 or 4 hurricane at mean high tide. Vinalhaven's wastewater system assets were scored based on whether they fell into a Sea Level Rise zone and the extent of inundation of that zone.	25%	Category 1	Category 2	Category 3	Category 4	Not Within Surge Zone
FEMA FIRM National Flood Hazard Maps	Information gathered FEMA Floodplain maps " *FIRM is an official map of a community that displays the floodplains, more explicitly Special Flood Hazard Areas (SFHA) and Coastal High Hazard Areas (CHHA), as delineated by FEMA. Both areas are subject to inundation by 1-percent-annual chance flood* ."	50%	VE	AE or AO	Just outside a FEMA Zone	---	Not within FIRM Layers

Notes:

* The scenario at which more than just the Carver's Harbor bridge gravity and force mains becomes inundated is 3.9 feet of SLR.

** The scenario at which more than just the Carver's Harbor bridge gravity and force mains become inundated is a Category 2 Hurricane.

Vinalhaven LoF Scores

	SLR Score	SLOSH Score	FEMA FIRM SCORE	LOF
Wastewater Treatment Facility	1	2	3	2.25
Gravity Mains	3	4	5	4.25
Force Mains	3	4	5	4.25
West Main Street (Fire Station) Pump Station	3	4	5	4.25
Atlantic Avenue (Lanes Island) Pump Station	3	4	5	4.25
High Street Pump Station	0	1	1	0.75
Indian Creek Pump Station	2	4	4	3.5
Sands Road Pump Station	2	4	4	3.5
Main Street Pump Station	5	5	5	5
Leo's Lane Pump Station	3	5	5	4.5
Chestnut Street Pump Station	1	3	1	1.5
School Street Pump Station	3	4	5	4.25

Note: LoF Score includes weight given for SLR, SLOSH and FEMA FIRM

Vinalhaven, Maine | Wastewater System Risk Assessment Results

	LoF	CoF	Risk	Risk Rank
Main Street Pump Station	5	3.75	19	1
West Main Street (Fire Station) Pump Station	4.25	3.75	16	2
Atlantic Avenue (Lanes Island) Pump Station	4.25	3.25	14	3
Gravity Mains	4.25	3.25	14	4
Force Mains	4.25	3	13	5
Leo's Lane Pump Station	4.5	3	14	5
School Street Pump Station	4.25	2.75	12	6
Sands Road Pump Station	3.5	3.25	11	7
Indian Creek Pump Station	3.5	2.75	10	8
Wastewater Treatment Facility	2.25	4.25	10	9
Chestnut Street Pump Station	1.5	2.75	4	10
High Street Pump Station	0.75	3	2	11

APPENDIX C: RESUMES & QUALIFICATIONS

Kevin J. Carney

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1 Lacy St. North Andover, Massachusetts 01845 (978) 689-2279

Summary:

An Engineering Specialist with over 30 years of extensive experience in product development of complex electro-optical and mechanical instrumentation and systems. Strong experience in laboratory operation, co-ordination of internal / external resources, and documentation in a highly technical atmosphere. Demonstrate leadership skills while building, testing and evaluating experimental or prototype systems from conception through early production. Perform field service tasks including installations, troubleshooting and resolving technical issues.

Experience:

November 2014 to present

Field Service Technician **Maine Water Vinalhaven, Maine**

• Operation and maintenance of all treatment facilities and equipment.
• Operation and maintenance of all water supply pumping and treatment facilities and equipment.
• Regulatory compliance with the MEPDES license requirements, State of Maine Drinking Water Regulations and the Safe Drinking Water Act.
• Operation, repair and maintenance of treatment plant equipment, SCADA control system and pumping stations.
• Inspection of all facilities to insure a safe, clean and presentable water production and water treatment environment.
• Collection and reporting of all water production and water treatment information necessary for regulatory compliance and company records.
• Receive, dispense, and record the use of water treatment chemicals. Insure availability and distribution of proper safety equipment and MSDS information for chemical handling.

January, 2010 to January 2014

Engineering Materials Specialist Textron Systems Wilmington, MA /NASA

I had the opportunity to help re-establish the Apollo heat shield material process, overcoming many early technical hurdles. The resulting material thermally and mechanically tested similar to heritage Avcoat. The program climaxed with installation of Avcoat on NASA Orion's EFT-1 full scale flight heat shield which was launched from NASA on December 5, 2014.

Responsibilities entailed interfacing with customers, generating materials fabrication processes, leading laboratory production staff and supporting engineering requirements and manufacturing documentation.

June, 2004 to January 2010

Engineering Test Specialist Textron Systems, Wilmington, MA

Systems Test Engineering Specialist performing detailed test planning including the researching, developing, and writing of test plans, procedures, Test Readiness Reviews (TRR) and final reports utilizing MS Office, and standard PC windows software while supporting manpower and scheduling of resources.

Responsibilities included the design of test methods and related test support equipment & fixturing required to support component, subsystem, and system development, integration & qualification testing.
Troubleshooting, maintenance and operation of complex mechanical & electronic equipment and instrumentation.

June, 2003 To June, 2004

Mechanical/Optical Engineer SenTech Inc. Stoneham, MA

Worked in an engineering environment to produce an Un-attended Ground Sensor for the US military in a joint venture.
My tasks have included, engineering design, writing the Acceptance Test Procedures (ATP), inspection of assembly, calibration of the test article, and conducting the instrument ATP's and field testing prior to customer shipment. Coordinated all lab tests and field service activities.

1986–March, 2003 Avco Research / Textron Systems, Wilmington, MA

Senior Engineering Specialist

Responsibilities while working in Test Operations were to inspect and test product at sub-system and system level while troubleshooting with a minimum amount of supervision.

Working with the design team for ProSpectra (spectrometer for agricultural applications), implemented many improvements in the product design. Applied my skills as the Field Engineer, installing spectrometers, collecting data, resolving technical issues, and training the customer in the products use. Worked at 3rd party facilities to validate and integrate products, and to propose changes that would simplify the manufacturing process at my facility.

Traveling worldwide, installing instrumentation in the laboratories of Iowa State University, Montana State University, laboratories in Australia, New Zealand and Canada training scientists, professors and students in the products operation. Also responsible for collecting data for the calibration database, resulting in a very comprehensive and accurate database which was incorporated into the ProSpectra algorithm.

Laboratory tasks included, maintaining the engineering laboratory in an ISO 9000 environment, controlling calibration records of all lab equipment, maintaining inventory, training and issuing daily work direction to other technicians.

Senior Technician

As a member of the Ultrasonic Engineering Team, responsibilities included building and testing a laser ultrasonic system for non-contact evaluation of coating thickness, structural deficiencies in electronic components, and high temperature measurements of silicon wafers during the manufacturing process. Responsible for procurement of all hardware, writing Bill of Materials, Assembly, Inspection, & Test Procedures, as well as optical alignment and performing experimental tests. This system required a YAG laser alignment process that I developed and performed on a daily basis.

Designed and machined data collection test fixtures for lab and manufacturing use. These fixtures carried infrared and laser systems that allowed us to achieve a database, which was instrumental in the upgrade and enhancement of the current high rate production electro-optic systems.

Assisting engineers in the design and build of a high power laser system that I eventually installed in Maui, HI on the mountain of Haleakala. The program was a LIDAR Sizing Experiment using an 800watt CO2 laser.

My level of security clearance is Secret.

Michael J. Cummons
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Nobleboro, ME 04555
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EDUCATION:

Bachelor of General Studies: Education Studies, May 2010
University of Maine at Farmington, Farmington, ME

EXPERIENCE:

***Interim Director of Service Delivery,* December 2018-Present**

- Develop 2019 goals for each Maine Water operating division
- Lead communication between service delivery and engineering
- Assist superintendents and engineering in prioritizing, planning and executing 2019 capital projects
- Develop and deliver Maine 2019 service delivery safety program
- Lead employee satisfaction efforts in Maine by leading the Maine Employee Satisfaction Working Group
- Achieve support of employee satisfaction initiatives from superintendents
- Provide day-to-day support to the superintendent team
- Coordinate water quality efforts with the Manager of Water Quality and superintendents
- Promote and deliver the Company's Core Values, Essential Elements and four Building Blocks to each division

***Superintendent, Camden-Rockland Division,* August 2017 – Present**

- Develop and manage annual operating and capital budget for the Camden-Rockland division
- Direct local managers in leading water treatment and distribution teams
- Ensure employee safety by administering Company safety program
- Promote employee development and growth of eleven employees
- Coordinate with Director of Water Quality to ensure water systems meet requirements of SDWA and MDWP
- Build and maintain strong relationships with town officials and critical water users in the community
- Promote and deliver the Company's Core Values, Essential Elements, and four Building Blocks at the regional level

***Service Delivery Coordinator,* August 2014 – August 2017**
Maine Water Company

- Manage water main replacement projects and new service line installations
- Install, repair, and maintain water distribution assets, including water main, service lines, valves, hydrants, meters, and vaults
- Communicate with town officials, public works directors, and general public regarding Company's construction projects
- Perform locates of underground water assets for DIGSAFE
- Use company as built data to improve company GIS mapping

***GIS Coordinator,* July 2012 – August 2014**
Maine Water Company

- Develop and coordinate effective water asset data collection processes in collaboration with superintendents, crew foremen, and field service representatives
- Provide mapping and technical support to engineering project managers, superintendents, and contractors for all capital water main replacement projects
- Train field service representatives, crew foremen and superintendents in practical uses of ArcGIS and ArcReader software
- Comply with all requirements of Chapter 140 of the Rules of the Maine Public Utilities Commission
- Assist the Director of Engineering in preparing company specifications, bid forms, detail sheets, WISC reports, and MPUC reports, as well as assisting with other back office support
- Perform locates of underground water assets for DIGSAFE
- Perform all duties in compliance with OSHA rules, company safety requirements and core values
- Perform standby duty for afterhours emergencies

***Field Service Representative,* May 2010 - July 2012**
Maine Water Company (formally Aqua Maine Inc.)

- Install, repair, and maintain water distribution assets, including water main, service lines, valves, hydrants, meters, and vaults
- Provide 24 hour service to customers and community members
- Obtain proper Maine State licenses and education credits to meet industry requirements
- Perform locates of underground water assets for DIGSAFE
- Perform standby duty for afterhours emergencies

LICENSES AND CERTIFICATIONS:

- Certificate of Completion from *Maine Management Candidate School,* 2013
- Certificate in *Manage for Success,* University of California - Sacramento, 2013
- State of Maine Class III Water Distribution Operator License, 2014 – Present
- State of Maine Class A Driver's License (CDL)

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