



**PLEASANT BAY  
ALLIANCE**

**Pleasant Bay Climate Action Adaptation Plan**

**JUNE 2023**

## **Selection of Case Study Sites and Establishment of Threshold Elevations**



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# Selection of Case Study Sites and Establishment of Threshold Elevations Pleasant Bay Climate Adaptation Action Plan

June 2023

**Prepared By:**

**Wright-Pierce**

11 Bowdoin Mill Island, Suite 140  
Topsham, ME 04086  
207.725.8721 | [wright-pierce.com](http://wright-pierce.com)

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# Section 1 Executive Summary

## 1.1 Overview and Background

The Pleasant Bay Alliance has received a grant from the Commonwealth of Massachusetts’ Municipal Vulnerability Preparedness program. That grant is funding the development of a Climate Adaptation Action Plan focused on the portions of Chatham, Harwich, Brewster and Orleans that are located on Pleasant Bay. The Plan will address vulnerability preparedness and identify creative solutions to protect natural coastal processes and enhance resilience of the barrier beach, inner shoreline, public water access and municipal utilities that may be affected by sea level rise and increased coastal storm intensity.

The Alliance has formed the Project Team to include:

- Center for Coastal Studies
- National Park Service
- Boston University
- Cape Cod Extension Service
- Wright-Pierce

The Alliance is serving as project manager and is coordinating the activities of the consultants and to facilitate the input of the four study-area towns.

This project is being conducted as five inter-related tasks scheduled to be completed over two years: mid 2022 to mid 2023. This Wright-Pierce report covers Task 2 of the grant.

## 1.2 Task 2 Summary

Task 2 of this project has two parts:

- Identification of case study sites and
- Determination of threshold elevations at those sites to judge vulnerability to sea level rise and increased storm surges.

Four types of municipal infrastructure are being considered:

- Town landings and boat ramps, and other public access points
- Stormwater infrastructure including outfalls, storm drains, and best management features
- Municipal water systems (excluding wellfield impacts)
- Municipal wastewater systems (existing and proposed sewer and pumping stations)

Following an inventory of municipal assets in these categories, 17 candidate sites were identified, subjected to a screening process. Eight case study sites emerged, including three locations for public Bay access, three areas of low-lying water mains, a stormwater treatment system and a wastewater pumping station.

Municipal officials were consulted about the uses of these sites, the existing structures and the history of past inundations. That information was supplemented with detailed site mapping to identify three to seven threshold elevations per site that are presented herein.

The boat ramps at the case study locations extend from the current water level up to about 8 to 10 feet, except for the ramp at Crows Pond which extends only to elevation 3 feet. The pier at Meetinghouse Pond is inaccessible at elevation 3.5 feet, and the ramp itself will be submerged at elevation 4 to 5 feet, and subject to wave damage at even lower still-water elevations. Boat storage areas at the case study locations will begin to be submerged at 4- to 5-foot elevations at Meetinghouse Pond and Cow Yard landing, but at only 2 to 3 feet at Crows Pond.

Encroachment on parking areas will occur at elevations of 6 to 8 feet

At the case study locations, water mains are located above 10 feet in elevation (near Tar Kiln Stream) but at only about 2 feet in the Harwich case study area. Access to hydrants will be hampered at water surface elevations of 6 feet in Harwich. There is a risk of road washout, and damage to the water mains, at all three locations, with the Harwich and Orleans locations most exposed to wave actions. Damage to these water mains will cut off water supply to homes and hydrants. As sea level rises, increased corrosion can be expected, particularly at the Orleans and Harwich locations.

The Harwich pump station is located in a cul-de-sac which will be inaccessible when water levels rise above 12 feet. Over-topping of the wet well and damage to the standby electrical generator will occur at water elevations above 13 feet. This station's location at the headwaters of Muddy Creek protects it against wave action.

The existing stormwater treatment system at Lonnie's Pond in Orleans will be overtopped at water elevations over 5.5 feet. Impacts on the herring run will occur at elevation 4.5 feet.

This compilation of threshold elevations will be used in later project tasks to assess the degree of threat from sea level rise and increased storm surges, and to identify mitigating measures for each site.

## Section 2 Selection of Study Sites

### 2.1 Criteria for Selection

One of the key components of the Pleasant Bay Alliance’s Climate Adaptation Action Plan (CAAP) is the identification of assets that may be impacted by sea level rise and increased storm damage, and an analysis of how these assets can be protected. As a first step, Wright-Pierce conducted an inventory of certain municipal assets across the four towns in the Pleasant Bay watershed. From that inventory, we have identified 17 study sites where impacts and protection strategies will be investigated. After applying a set of evaluative criteria, that list was reduced to eight sites which are the subject of detailed review. This section of the report summarizes our findings.

#### 2.1.1 Categories of Municipal Assets

The focus of this task has been four types of municipal assets in or near Pleasant Bay:

- Facilities for public access to the Bay
- Stormwater management facilities
- Water supply assets
- Wastewater facilities

#### 2.1.2 Nature of Potential Impacts

In identifying municipal assets for possible evaluation, it is important to consider the nature of the potential climate-change impacts. Broadly speaking, these assets could be negatively impacted by sea level rise and increased storm intensities in the following ways:

- Physical damage requiring repairs or reconstruction, such as the destruction of a pier, damage to a low-lying wastewater pumping station, or the wash-out of a roadway in which water or sewer lines are buried.
- Restricted access during times of high water, such as the inability of fire trucks to reach hydrants on submerged roadways or the loss of access or parking at boat ramps.
- Reduction in stormwater hydraulic capacity, such as the submergence of a storm drain outlet causing upstream flooding.

Some impacts are solely associated with sea level rise, so-called “blue sky” impacts, which could occur in the absence of storms. Other hazards include storm impacts due to heightened storm surges, exacerbated by sea level rise. This investigation does not address other climate-change-related impacts due to increased rainfall amounts and intensities, high winds, droughts, or extreme temperatures. Issues solely related to roadways are being considered by a parallel study by the Cape Cod Commission and are not part of this investigation. Also not considered are increases in water table elevations and resulting impacts such as increased sewer infiltration, or changes in public water supply well capacity or water quality.

Parallel studies in the Climate Adaptation Action Plan are identifying specific degrees of sea level rise and storm surges. While that part of the plan was underway, this inventory looked at these categories of assets located in low-lying lands (below 10- and 20-foot elevations) as an initial screening tool. Note: the local storm of record is the January 2018 Nor’easter that caused flooding to elevation 7.8 feet, observed in Outermost Harbor, Chatham.

### **2.1.3 Data Sources**

We contacted town officials and obtained information and mapping of assets in these categories. We supplemented that information with first-hand observations and several site inspections.

## **2.2 Results of Inventory**

This exercise identified over 63 sites where the four types of municipal infrastructure exist in low-lying areas and/or adjacent to the Bay. A summary of those identified sites is as follows:

### **2.2.1 Public Access**

There are three public beaches off Route 28:

- Jackknife Beach in Chatham, near the outlet of Muddy Creek
- Pleasant Bay Beach in Harwich, near the outlet of Muddy Creek, and
- Route 28 Beach in Orleans, near the outlet of Tar Kiln Stream

The four towns also have 27 other public access points, including town piers, boat ramps and pedestrian access points. Chatham and Orleans account for 26 of the designated public access points to Pleasant Bay. Brewster has no town-owned access points, but this inventory includes the quasi-public facilities of Pleasant Bay Community Boating, located where the three towns converge at the short Brewster frontage on the Bay.

### **2.2.2 Stormwater Management Facilities**

The only municipal stormwater outfalls in the Pleasant Bay watershed are in Orleans (18) and Chatham (8), other than MassDOT-owned outfalls. Only two of these outfalls have best management practices, one on Frostfish Creek in Chatham and one at Lonnie's Pond in Orleans.

### **2.2.3 Water Supply Infrastructure**

None of the towns has water supply wells or treatment systems located near the Bay or in low-lying areas. Both Chatham and Orleans have many miles of water mains and hundreds of hydrants located in roadways or easements where the existing ground surface is at or below 20 feet above mean sea level. Brewster has a short length of water main in a low-lying area near Tar Kiln Marsh, and Harwich has about 6,000 feet of main in low areas on Route 28 and the easterly end of Bay Road. An Orleans water main crosses Tar Kiln Stream on a Route 28 bridge, and another section of water main exists at low elevation along the north side of Arey's Lane.

### **2.2.4 Wastewater Infrastructure**

Most of the existing wastewater infrastructure in the Pleasant Bay watershed is in East Harwich and the vast majority of it is located in areas at least 20 feet above sea level. Similar elevations are seen for recent sewer extensions in Chatham and for the proposed Meetinghouse Pond sewer project in Orleans. All three towns have provided or will provide sewer service to low-lying homes using grinder pumps and low-pressure mains. Homes on Harden Lane in Harwich are now served by a low-lying municipal grinder pump station near the headwaters of Muddy Creek. Dozens of low-lying homes in Orleans will be served by individual grinder pumps around Meetinghouse Pond in a project that is due to be constructed in 2023 to 2025. Future phases of Chatham's wastewater collection system will serve many low-lying areas after 2030.

### 2.2.5 Short List of Candidates for Case Studies

With the goal to evaluate the risks and potential improvements at eight sites across the watershed, the list of 63 sites was reviewed against a set of evaluative criteria, as follows:

1. Geographic Range.
  - Northerly, mid and southerly locations
  - At least one site in each town
  - Open Bay vs. headwaters ponds
2. Range of hazards.
  - Inconvenience such as loss of parking
  - Loss of hydraulic capacity due to pipe outlet submergence
  - Inoperability due to submergence
  - Public health and safety, such as lack of access to hydrants for firefighting
  - Structural damage such a road wash-out
3. Range of asset type; one site in each of the four categories.
4. Consistency with the goals of the Municipal Vulnerability Planning program:
  - Address environmental justice issues
  - Allow nature-based solutions
  - Reflect community-identified issues.
5. Availability of engineering and survey data.
6. Representative of regional solutions.

Seventeen potential locations were identified from this broad inventory. Those short-listed sites are summarized in Table 2-1 and shown on Figure 1.

The 17 candidate study sites include:

- 2 public beaches
- 7 piers and landings
- 4 areas of low-lying water mains and hydrants
- 2 areas of low-lying wastewater pump stations
- 2 stormwater outfalls

A memorandum describing these short-listed study sites was reviewed by representatives of the four towns. Town representatives were asked to supplement this inventory for items that may have been missed, and to comment on the most important sites in their towns. Based on this input, the candidate site list was adjusted, and the result is shown in Table 2-1.



**Table 2-1 Short-List of Candidate Sites for Case Studies**

Selected sites shown in **Bold**.

|                                   | Brewster                              | Chatham   | Harwich                                | Orleans  |
|-----------------------------------|---------------------------------------|---|--|--|
| Public Water Access               | PB Community Boating                  | <b>Crows Pond Landing</b><br><b>Cow Yard Landing</b><br>Jackknife Beach<br>Ryder Cove Landing | Round Cove Ramp<br>Pleasant Bay Beach  | <b>Meetinghouse Pond Pier</b><br>Portanimicut Landing                                  |
| Municipal Water Supply Facilities | <b>Water mains near Tar Kiln Road</b> |   | <b>Water mains on Rt 28 and Bay Rd</b> | <b>Water main on Rt. 28 Bridge across Tar Kiln Stream</b><br>Water Main on Arey's Lane |
| Municipal Wastewater Facilities   |                                       |   | <b>Harden Lane Pump Station</b>        | Future Meetinghouse Pond grinder pumps   |
| Municipal Stormwater Facilities   |                                       | Ryder Cove Rd outfall   |  | <b>Lonnie's Pond stormwater treatment and herring run</b>                              |

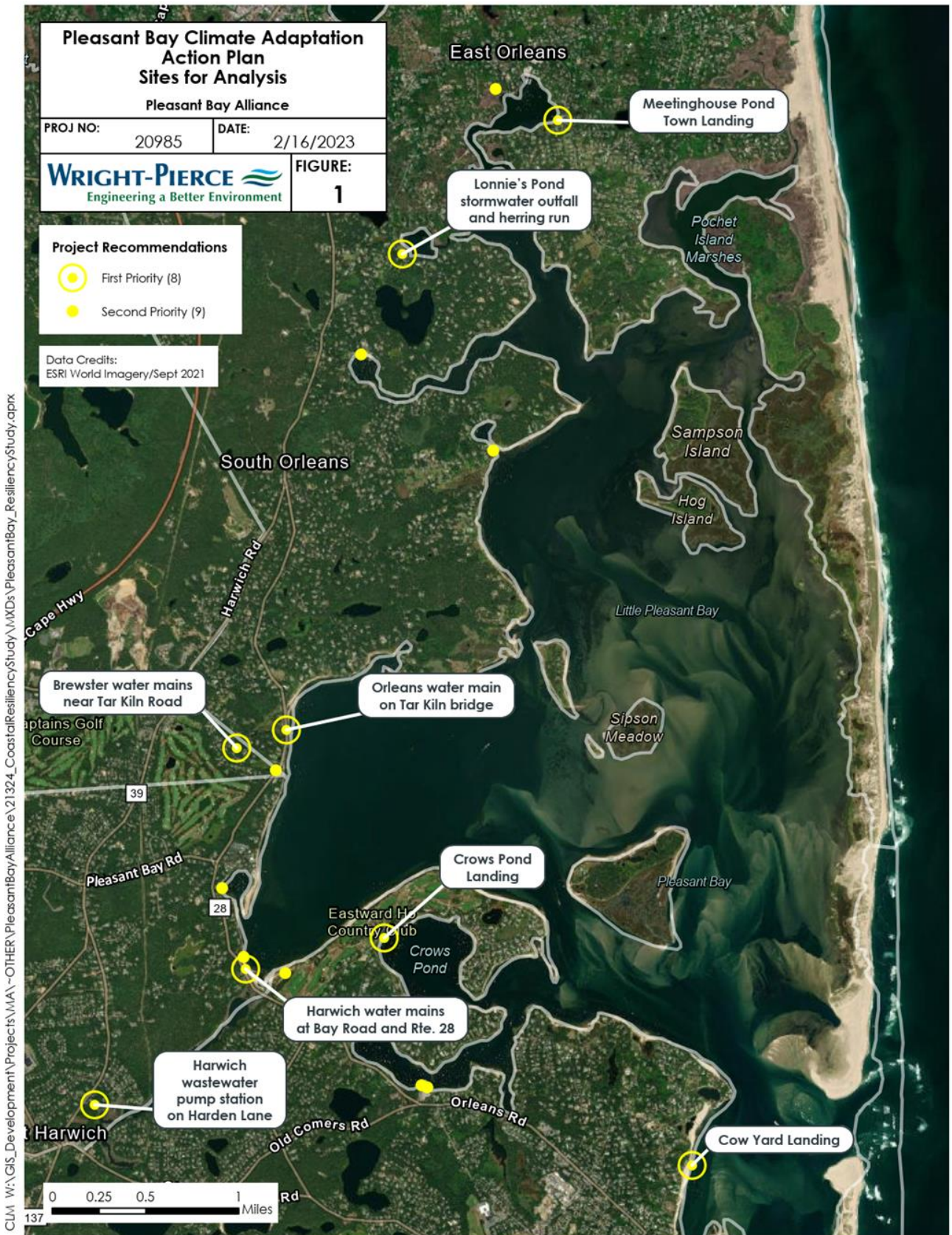
### 2.3 Selected Sites for Case Studies

Table 1 identifies both the short-list of 17 candidate sites and the eight sites selected for detailed evaluation (bold font). These sites reflect town priorities and accomplish the selection criteria as follows:

- There is at least one site in each of the four watershed towns.
- All of the four classes of infrastructure are represented.
- Sites range across the study area from Crows Pond and Cow Yard landings in the south to the town landing on Meetinghouse Pond on the north.
- Sites include some directly on the Bay and some on headwaters pond and streams.
- The Crows Pond landing is one of the locations where individual and small-scale commercial shellfish harvesters access the Bay.
- There are multiple opportunities for nature-based solutions to be implemented.

Some sites include more than one type of targeted infrastructure. For example, the Lonnie's Pond site includes a stormwater treatment system, a herring run and a town boat ramp. The Crows Pond landing is also the site of a future Chatham wastewater pumping station.

This site identification and screening process was based on readily available information on elevations, structures, functions, etc. As more detailed information is compiled for these eight sites, we may find that one or two sites may not be as amenable to study as first thought, and one or two of the shortlisted sites could be substituted.



## Section 3 Evaluation of Selected Study Sites

### 3.1 Site 1: Meetinghouse Pond Town Landing

Meetinghouse Pond Town Landing is located in Orleans off Barley Neck Road. The Town Landing provides access to the tidally influenced Meetinghouse Pond and offers multiple recreational uses including an unpaved boat ramp, boat storage area, and a wooden pier leading to a floating dock. The pier was constructed in 2010. New stormwater infrastructure was installed in 2019 along with parking improvements to the site.



The most vulnerable aspects of this site are the pier and the boat storage area. The pier is inaccessible when water rises more than 4 to 5 feet above mean sea level, an event that may occur now under very extreme conditions but will happen with increasing frequency as sea level rises. The pier is only slightly higher than its access walkway and could be damaged by wave action with even smaller increases in average water level. Wave impacts will become more frequent as sea level rises and storms increase in intensity. The boat ramp can accommodate significant increases in water level and should still be functional even with water levels 5 feet higher than current conditions. The boat storage area will gradually shrink in usable area. The boat storage area’s unvegetated and sandy surface is particularly susceptible to erosion. Both the lower and upper parking areas are not likely to be inundated with sea level rise expected in the foreseeable future.

A 2.5-foot rise in sea level would result in inundation of the pier at every high tide. Lesser amounts of sea level rise would have less frequent impacts to day-to-day operations.

**Table 3-1 Meetinghouse Pond Town Landing Elevations**

| Asset                    | Elevation (NAVD88) |
|--------------------------|--------------------|
| Upper parking area       | 19.5 to 22         |
| Lower parking area       | 8.5 to 18.5        |
| Boat storage area        | 4.5 to 8           |
| Boat ramp elevation      | 0 to 8.5           |
| Walkway area to pier     | 3.5 to 5           |
| Top of pier planking     | 4.8                |
| Bottom of pier stringers | 3.9                |





**3.2 Site 2: Lonnie’s Pond Stormwater Outfall and Herring Run**

Lonnie’s Pond (also referred to as Kescayo Gansett Pond) is a coastal embayment located in Orleans and accessed by Herring Brook Way. This site has a town landing, roadside stormwater treatment, and a herring run that connects Lonnie’s Pond to the upstream Pilgrim Lake, an important freshwater spawning ground for the species. The herring run begins in a culvert/structure under Herring Brook Way and meanders through a wooded area until it connects with Pilgrim Lake.

The town landing on Lonnie’s Pond is a paved ramp that extends from Herring Brook Way to the pond, with enough width for limited parking alongside the ramp. There is no designated parking area or other utilities at this location. The ramp currently operates over a range of tidal variations. With a rise in sea levels, the available length of the ramp will be diminished, as would be potential for parking, but the landing is expected to be able to function. During rain events, this ramp acts as a drainage outlet for nearby private properties, with significant stormwater flows that cause erosion to the unpaved sides of the landing. This will worsen during more intense storms.

The herring run and stormwater infrastructure are both located at a local low point of Herring Brook Way. This location is only 5 to 6 feet above the current mean sea level, and 1 to 2 feet above the highest astronomical tide. Routine inundation of this section of roadway is predicted in the ongoing Cape Cod Commission study. The stormwater infrastructure is a storm drain line and nearby catch basin connected to an unmaintained StormTreat system, which utilizes wetland plants to help to treat the stormwater before it is discharged into Lonnie’s Pond. This system was installed at least 20 years ago and needs immediate replacement due to its condition. The Town of Orleans has begun planning to re-design this stormwater system. That work will consider upgrading or replacement of the existing StormTreat system which is anticipated to be removed as early as Fall 2023. This area could face daily inundation with about 3 feet of sea level rise, with less frequent (but still troublesome) impacts increasing over time.

**Table 3-2 Lonnie’s Pond Elevations**

| Asset  | Elevation (NAVD88) |
|--|--------------------|
| Top of StormTreat tanks                          | 5.5 to 6           |
| Catch basin grate                                | 5.5 to 6           |
| Top of fish passage channel at Herring Brook Way | ~4.5               |
| Boat ramp range                                  | 0 to 10            |
| Road elevations                                  | 5.5 to 6.5         |



The beginning of the herring run is a concrete channel located below Herring Brook Way. This portion of the run already experiences high water impacts, where the water spills over the concrete channel walls, depositing fish on the exterior of the fishway. With future increases in sea level and more intense storms, it is likely that these problems will worsen. The herring run is also aging and is planned to be rehabilitated or upgraded in the coming year.



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**3.3 Site 3: Orleans Water Main on Tar Kiln Bridge**

The Orleans Water Department maintains a water main on the Route 28 bridge over Tar Kiln Stream. The bridge is owned and maintained by Mass DOT, but the water main and the main’s connection to the bridge is maintained by the Town of Orleans. The pipe is a 12-inch cast iron water main with pipe insulation that is attached to the underside of the bridge on the inland (western) side of the bridge. The pipe supports were recently replaced in 2021 with all new stainless-steel connections that provide a robust attachment to the underside of the bridge. It is estimated that the pipe is original to the 1960s.

The pipe and pipe support elevations vary across the length of the bridge but are, at the lowest point, 12.6 feet (NAVD88). The bridge abutments are located at elevation 9.6 (NAVD88). For this reason, it is anticipated that the greatest risk to the infrastructure would be the condition of the existing pipe and any corrosion occurring within this extreme saline environment that could reduce the expected lifetime of the pipe material. However, as sea levels rise, the frequency of inundation will increase, and the bridge could see impacts from more frequent storm events. The storm surge at this location could exacerbate the corrosion of the pipe but is not anticipated to pose a significant threat to the structural integrity of the pipe or pipe supports because the pipe is supported within a utility bay tucked up above the bridge piers and abutments. Waves would travel across the underside of the bridge and would have a significant amount of their energy dispersed prior to reaching the protected pipe location. In general, if the bridge structure or road approaches were damaged by intense storms, the pipe could also be impacted. The analysis of bridge structural integrity was outside of the scope of this analysis.

**Table 3-3 Tar Kiln Water Main Elevations**

| Asset                                    | Elevation (ft) |
|--|----------------|
| Utility Bay where pipe supports attached | 12.6 to 14.6   |
| Bridge abutment                          | 9.6            |
| Bridge pier                              | 10.7           |
| Bank elevations on abutments             | ~10            |







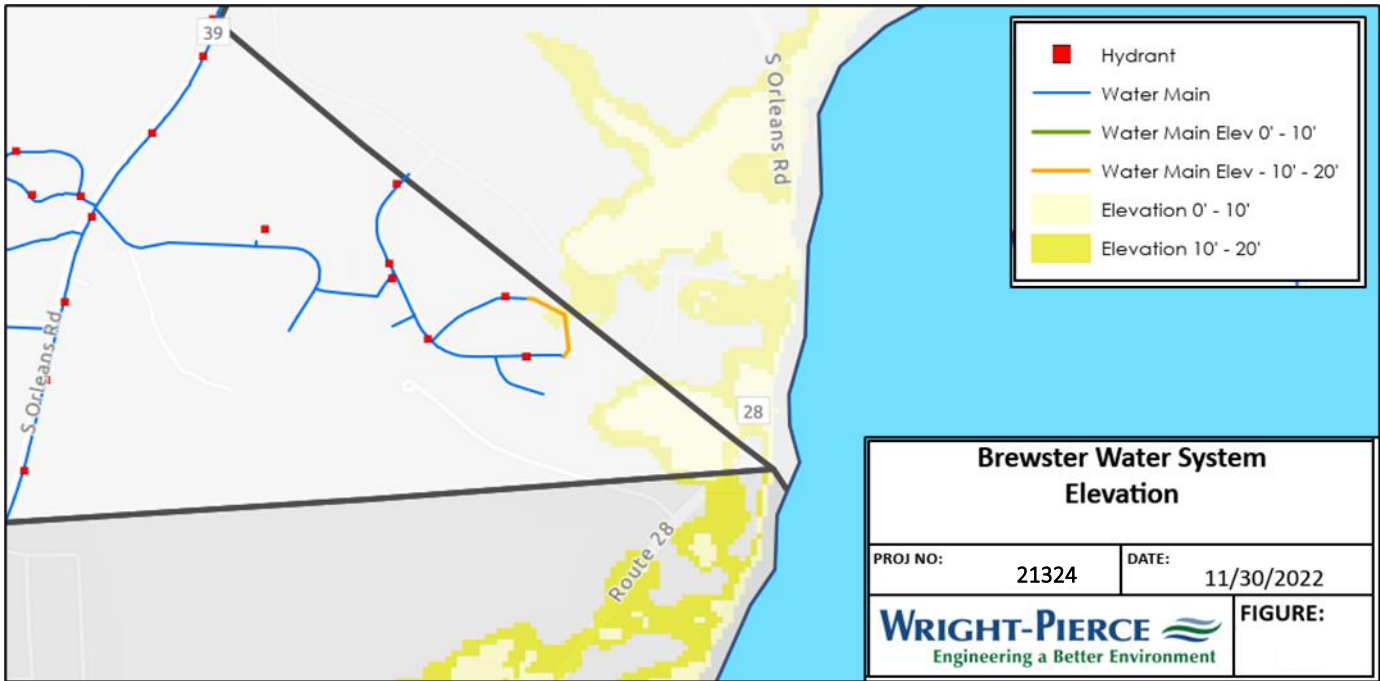
**3.4 Site 4: Brewster Water Mains near Tar Kiln Road**

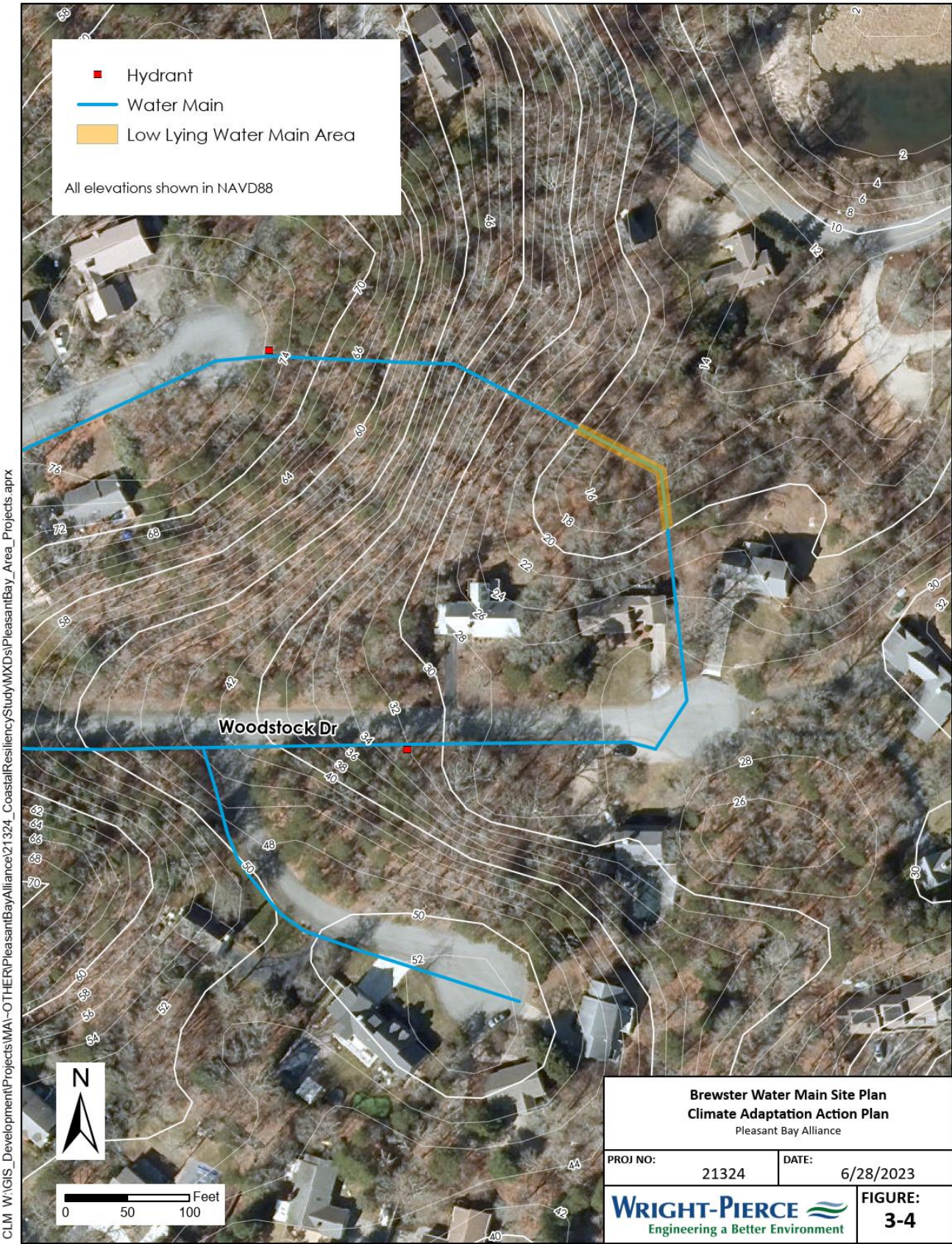
One of the water mains that the Town of Brewster owns and maintains is located near wetlands surrounding Tar Kiln Stream. This water main location can be seen in the below map, highlighted in orange. The lowest ground surface elevation at this location is approximately 14.5 (NAVD88), which would put the pipe a few feet below that at around elevation 10.5 (NAVD88). It is not anticipated that this pipe will be adversely impacted by gradual sea level rise for the foreseeable future. However, as sea levels rise, and storm surges increase, this low-lying area could be subject to erosion and possible wash-out of the water main.

There are two fire hydrants nearby this section of pipe, but the ground surface elevation in the area steeply slopes up to where the fire hydrants are located, lessening their risk of impacts by rising sea levels. However, this section of the water main is a loop system, so if the low portion were damaged, there could be pressure loss or other problems in the rest of the line, including the locations with the hydrants.

**Table 3-4 Brewster Water Main Elevations**

| Asset                   | Elevation (NAVD88) |
|-------------------------|--------------------|
| Pipe elevation          | >10.5 +/-          |
| Hydrant elevations      | >35                |
| Ground / road elevation | >14.5              |





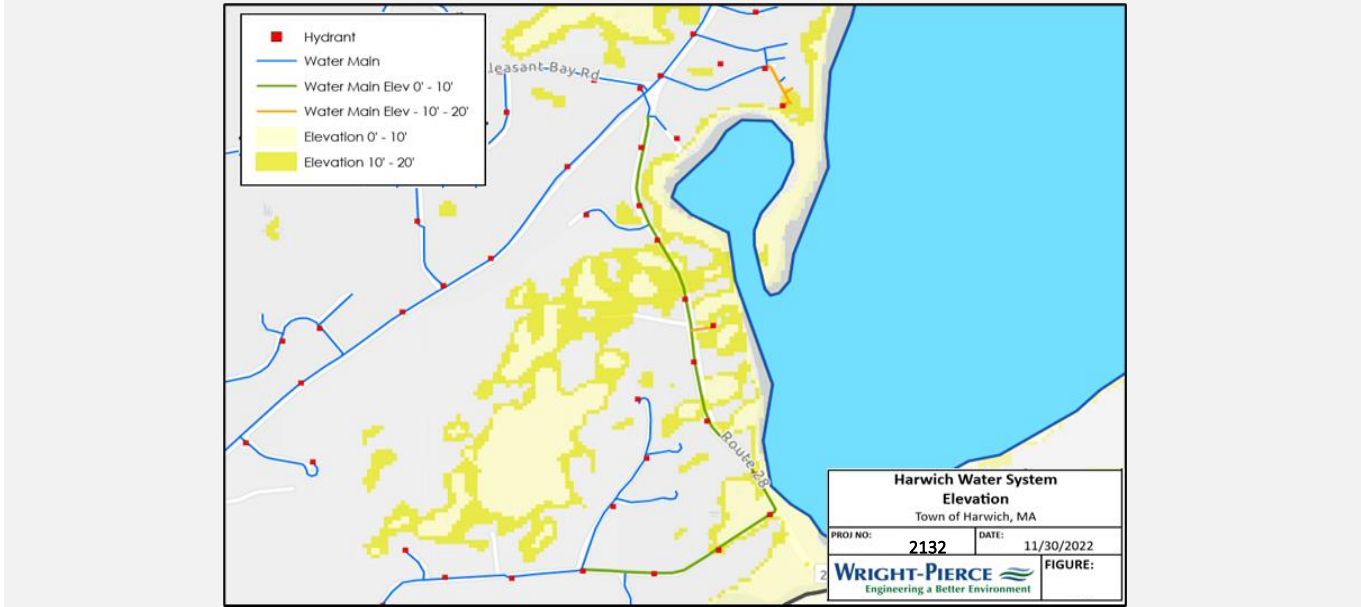
**3.5 Site 5: Harwich Water Mains at Bay Road and Rt. 28**

One of the water mains that the Town of Harwich owns and maintains is located near a low-lying area at the intersection of Bay Road and Route 28. At that location, Route 28 is immediately adjacent to Pleasant Bay at the mouth of Muddy Creek. This water main location can be seen in the map below, highlighted in green. The lowest ground surface elevation at this location is approximately 6 (NAVD88), which would put the pipe a few feet below that at around elevation 2 to 3 (NAVD88). The mean high-water elevation for this area is about 2.3, meaning that a very small increase in sea level (of only 0.5 feet) could cause the water main to be below the water table in this area. The interface between salt and fresh groundwater will slowly move landward as sea level rises and increasingly pose corrosion risks to the pipe. Wave impacts will also become more frequent as sea level rises and storms increase in intensity and could pose wash-out risks to the road and buried water utilities. The Cape Cod Commission has been researching impacts to low-lying roadways, and its findings will also provide insight on potential roadway concerns. As you travel further north on Route 28, or further west on Bay Road, the road elevations increase quickly to be well above 20 feet. Further stretches of the road could be inundated within a longer time horizon, or sooner if they also are experiencing wave action from coastal storms.

**Table 3-5 Harwich Water Main Elevations**

| Asset                   | Elevation (NAVD88) |
|-------------------------|--------------------|
| Pipe elevation          | >2 (+/-)           |
| Hydrant elevations      | Varies, >10        |
| Ground / road elevation | >6                 |

The road in this area could be impacted portions of each day with sea level rise of 3-4 feet, and infrequently with a rise of just 2 feet or from a major coastal storm. There are multiple hydrants nearby this section of pipe, with the lowest hydrant located at elevation 10. The locations of the hydrants on the road could be infrequently impacted during the highest astronomical tides if sea levels rose 6 feet. Conservative sea level rise projections developed by other members of the project team show that sea levels would not reach these elevations until late this century, or earlier if combined with wave action from coastal storms. This could restrict access to the hydrants along this portion of Route 28.





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**3.6 Site 6: Harwich Wastewater Pump Station on Harden Lane**

The Harwich Water and Sewer Department maintains a relatively small wastewater pump station located at the cul-de-sac of Harden Lane in Harwich. The station was installed in 2021 and serves approximately 6 houses along the road. The station consists of a prefabricated FRP pump station with grinder pumps and a standby generator.

The station is immediately adjacent to Muddy Creek, which has a FEMA 100-year floodplain elevation in the area of 11 feet (NAVD88). The pump station electrical equipment and generator are situated at elevation 14 feet to be above the FEMA floodplain. Based on the available topographic data, the elevation of Muddy Creek is well below the elevation of the pump station and indicates that sea level rise itself would not be likely to impact this station within the planning horizon of the study. In addition, wave impacts are not anticipated because the station is located so far inland up Muddy Creek that waves would be attenuated before they reach this location.

However, more information about the storm surges up Muddy Creek, specifically the storm-tide pathway analysis, is expected to provide insights into the Muddy Creek hydraulics and indicate the degree of risk for flooding at this location. The pump station may be above all threshold elevations of concern, but the storm-tide pathway analysis is an important factor in that determination.

**Table 3-6 Harwich Wastewater Pump Station Elevations**

| Asset                           | Elevation (NAVD88) |
|---------------------------------|--------------------|
| Bottom of generator             | 14                 |
| Bottom of enclosure             | 14                 |
| Top of wet well                 | ~13.5              |
| Electrical pedestal top of slab | 14                 |





**3.7 Site 7: Crows Pond Landing**

The Crows Pond Landing is a Town-owned boat ramp on Crows Pond, located off Fox Hill Road in Chatham. The landing consists of a concrete ramp that was installed in 1989, with riprap embankments. There is an unpaved parking area along the driveway of the landing entrance and there is a storage area for small boats on the beach in the area. The concrete ramp is located at elevations 0 to 3 (NAVD88) and the approach to the boat ramp area continues up the beach to the parking area at elevation 6.

The boat ramp and sandy area leading from the parking lot to the ramp already experience overtopping during high tide events and storms, and this could significantly worsen with sea level rise of just a few feet. Based on conservative sea level rise projections by other members of the project team, over the next 5 to 10 years, the ramp could be completely overtopped during each high tide event. Sometime in the next few decades mean sea level could rise to the point where the ramp is almost always inundated, even at low tide. There could also be frequent impacts to the parking area and the boat storage areas based on conservative sea level rise assumptions of just 2 feet. As sea levels rise, the frequency of inundation will increase. Wave impacts will also become more frequent as sea level rises and storms increase in intensity and could further displace the riprap embankment of the landing.

**Table 3-7 Crows Pond Landing Elevations**

| Asset                                    | Elevation (ft) |
|--|----------------|
| Parking lot area                         | 6 to 11        |
| Boat storage area                        | 2 to 3         |
| Sandy area from parking lot to boat ramp | 3 to 7         |
| Boat ramp elevation range                | -1 to 3        |
| Bottom of boat ramp structure            | <-1            |



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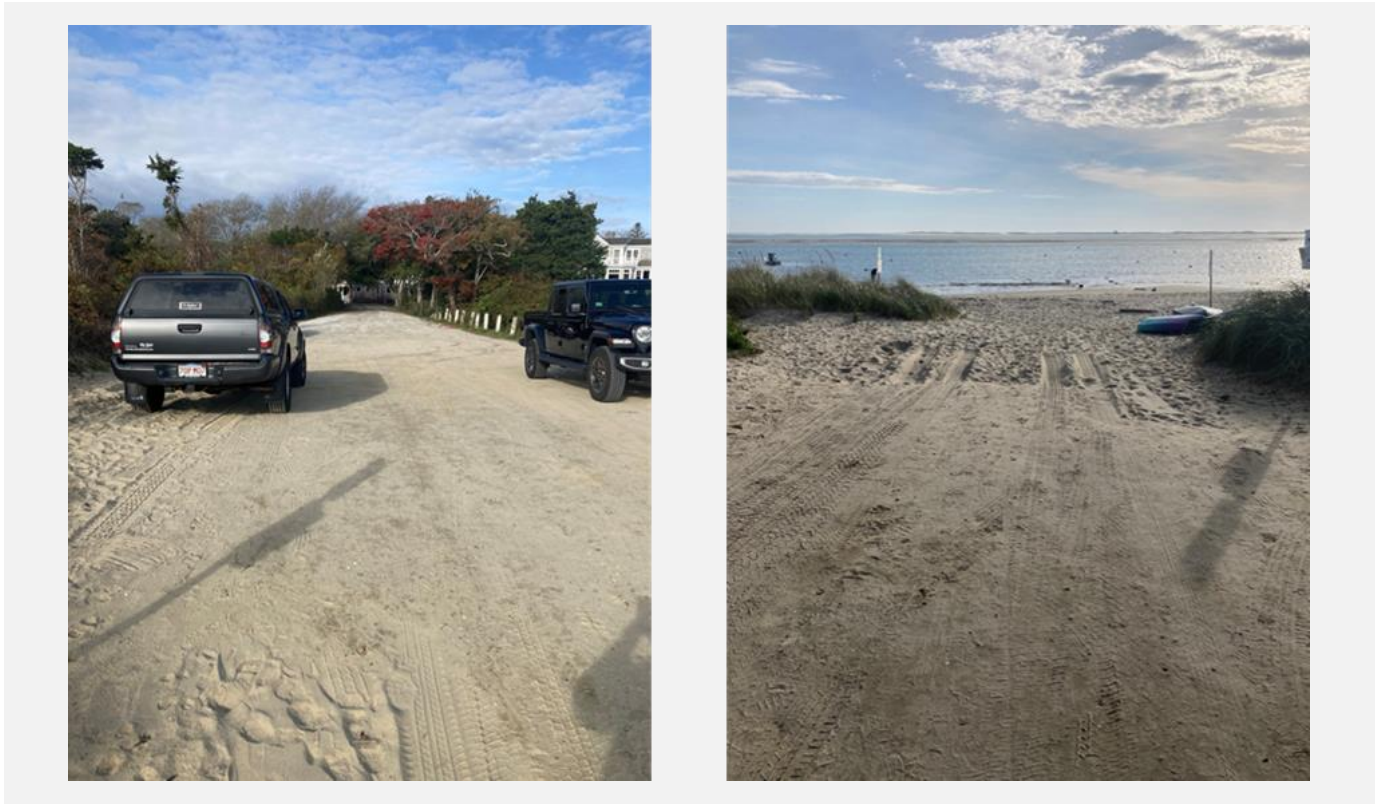
**3.8 Site 8: Cow Yard Landing**

Cow Yard Landing is a Town-owned boat ramp located in Chatham off Cow Yard Lane. The landing provides direct public access to Pleasant Bay and Chatham Harbor and was originally laid out in 1890 with minor improvements in 2007 and 2008. The launch area is all sand and gravel leading down to the beach and has no paved areas. The parking for the site is restricted to one side of the road coming into the launch, and it is very crowded in the summertime. Some boats are stored on the beach along the waterfront, but there is no other infrastructure at this site. At this site is the discharge point of the MassDOT stormwater system draining Route 28.

The boat ramp elevation ranges from 0 to approximately 9 across the site, with already frequent inundation due to the normal tidal cycles on the beach. With a rise in sea levels, the available length of the access road and the beachfront will be significantly diminished, as would be the area for parking, but the ramp can accommodate significant increases in water level and should still be functional even with water levels 5 feet higher than current conditions. There could also be frequent impacts to the boat storage areas in the next 10 or so years based on even conservative projections of sea level rise above the current mean high-water line. However, as sea levels rise, the frequency of inundation will increase.

**Table 3-8 Cow Yard Landing Elevations**

| Asset                     | Elevation (NAVD88) |
|---------------------------|--------------------|
| Parking lot area          | 7 to 9             |
| Boat storage area         | 5 to 8.5           |
| Boat ramp elevation range | 0 to 9             |





### 3.9 Summary of Threshold Elevations

Table 3-9 summarizes the key elevation data for the eight sites. It also lists the current uses of the sites and outlines the potential impacts on structures and uses.

**Table 3-9 Site Evaluation Data**

| Site                                | Uses   | Risks   | Key Elevations                         |                            |
|-------------------------------------|--|---|--|----------------------------|
| 1. Meetinghouse Pond Landing        | Launch of motorized boats<br>Launch of canoes, kayak, SUPs<br>Small boat storage<br>Boarding floating boats<br>Parking for boat ramp area<br>Stormwater system | Submergence of ramp<br>Erosion of ramp<br>Submergence of storage area<br>Submergence of pier<br>Wave damage to pier<br>Loss of parking and access                                 | Upper parking area                     | 19.5 to 22                 |
|                                     |  |   | Lower parking lot                      | 8.5 to 18.5                |
|                                     |  |   | Boat storage area                      | 4.5 to 8                   |
|                                     |  |   | Walkway area towards pier              | 3.5 to 5                   |
|                                     |  |   | Top of pier planking                   | 4.8                        |
|                                     |  |   | Bottom of pier stringers               | 3.9                        |
|                                     |  |   | Boat ramp elevation range              | 0 to 8.5                   |
| 2. Lonnie's Pond SW Treatment       | Stormwater treatment<br>Herring passage<br>Freshwater drainage to ocean<br>Boat ramp<br>Ecological area  | Disruption of stormwater treatment<br>Disruption of fish passage<br>Saltwater intrusion to freshwater pond<br>Submergence of boat ramp<br>Loss of parking and access              | Top of storm treat system              | 5.5 to 6                   |
|                                     |  |   | Catch basin elevation                  | 5.5 to 6                   |
|                                     |  |   | Top of fish passage channel            | ~4.5                       |
|                                     |  |   | Boat ramp elevation range              | 0 to 10                    |
|                                     |  |   | Road elevations (accessibility)        | 5.5 to 6.5                 |
| 3. Water Main on Tar Kiln Bridge    | Public water distribution  | Wave damage to water line<br>Discontinuity of potable water services<br>Damage to the water line connections<br>Erosion of abutment near buried line<br>Pipe and hangar corrosion | Bottom of pipe                         | 12.6 to 14.6 (utility bay) |
|                                     |  |   | Top of pipe                            |                            |
|                                     |  |   | Bridge abutment (bottom)               | 9.6                        |
|                                     |  |   | Bridge pier (bottom)                   | 10.7                       |
|                                     |  |   | Bank elevations on abutments           | ~10                        |
| 4. Brewster Water Mains - low lying | Public water distribution<br>Hydrants for fire suppression<br>Shut off valves  | Damage to water line<br>Discontinuity of potable water services<br>Discontinuity of emergency fire services<br>Pipe corrosion<br>Loss of hydrant valve access                     | Bottom of pipe                         | >10.5                      |
|                                     |  |   | Top of pipe                            |                            |
|                                     |  |   | Hydrant elevations                     | >35                        |
|                                     |  |   | Ground/road elevations (accessibility) | >14.5                      |

| Site                                  | Uses  | Risks  | Key Elevations                                   |                        |
|---------------------------------------|---|--|--|------------------------|
| 5. Harwich Water Mains<br>- low lying | Public water distribution<br>Hydrants for fire suppression<br>Shut off valves                               | Damage to water line<br>Discontinuity of potable water services<br>Discontinuity of emergency fire services<br>Pipe corrosion                          | Bottom of pipe                                   | >2                     |
|                                       |   |  | Top of pipe                                      |                        |
|                                       |   |  | Hydrant elevations                               | site specific, but >10 |
|                                       |   |  | Road elevations (accessibility)                  | >6                     |
| 6. Harwich Wastewater<br>Pump Station | Wastewater transmission   | Damage to the wastewater PS<br>Discontinuity of wastewater services  | Bottom of generator                              | 14                     |
|                                       |   |  | Bottom of grinder unit enclosure                 | 14                     |
|                                       |   |  | Top of the wet well                              | 13.5                   |
|                                       |   |  | Electrical pedestal top of slab<br>grade at PS   | 14<br>13               |
| 7. Crows Pond Boat<br>Ramp            | Launch of canoes, kayak, SUPs<br>Small boat storage<br>Parking for boat ramp area                           | Submergence of ramp<br>Erosion of ramp<br>Submergence of storage area<br>Submergence of boat ramp<br>Damage to boat ramp<br>Loss of parking and access | Parking lot area                                 | 6 to 11                |
|                                       |   |  | Boat storage area                                | 2 to 3                 |
|                                       |   |  | Sandy area from parking lot to boat<br>ramp area | 3 to 7                 |
|                                       |   |  | Boat ramp elevation range                        | -1 to 3                |
|                                       |   |  | Bottom of boat ramp supports                     | <-1                    |
| 8. Cow Yard Boat Ramp                 | Launch of canoes, kayak, SUPs<br>Small boat storage<br>Parking for boat ramp area and<br>emergency vehicles | Submergence of ramp<br>Erosion of ramp<br>Submergence of storage area<br>Submergence of pier<br>Damage to pier<br>Loss of parking and access           | Parking Lot Area                                 | 7 to 9                 |
|                                       |   |  | Boat Storage Area                                | 5 to 8.5               |
|                                       |   |  | Boat ramp elevation range                        | 0 to 9                 |
|                                       |   |  |  |                        |
|                                       |   |  |  |                        |

## Section 4 Conclusions

Eight Pleasant Bay locations were selected to enable an evaluation of risks and potential remedies related to increased water levels at public boat landings, and at water, wastewater and stormwater infrastructure. The selected case studies represent a broad range of uses, settings and risks for damage related to sea level rise and increased storm surges. These eight locations are shown in Figure 1.

Public access to the Bay:

- Meetinghouse Pond Pier and Boat Ramp in Orleans
- Crows Pond Landing in Chatham
- Cow Yard Landing in Chatham

Water Mains and Hydrants

- Orleans main on Route 28 bridge over Tar Kiln Stream
- Brewster mains at headwaters of Tar Kiln Stream
- Harwich mains at intersection of Bay Road and Route 28

Wastewater Pump Station

- Harwich pump station on Harden Lane

Stormwater facilities

- Stormwater treatment system at Lonnie's Pond in Orleans

Task 2 of this project has identified the components of municipal assets that are at varying degrees of risk. The assets are characterized by their current elevations, for later comparison with projections of sea level rise and storm surge. In the next phase of this study, measures will be proposed to reduce the impacts of sea level rise on these municipal assets. The likelihood of sea level reaching the key elevations will be evaluated to establish appropriate timing and design life of improvements.

### 4.1 Public Access to the Bay

The boat ramps at the case study locations extend from the current water level up to about 8 to 10 feet, except for the ramp at Crows Pond which extends only to elevation 3 feet. The pier at Meetinghouse Pond is inaccessible at elevation 3.5 feet, and the ramp itself will be submerged at elevation 4 to 5 feet, and subject to wave damage at even lower still-water elevations. Boat storage areas at the case study locations will begin to be submerged at 4- to 5-foot elevations at Meetinghouse Pond and Cow Yard landing, but at only 2 to 3 feet at Crows Pond.

Encroachment on parking areas will occur at elevations of 6 to 8 feet

### 4.2 Water Mains and Hydrants

At the case study locations, water mains are located above 10 feet in elevation (near Tar Kiln Stream) but at only about 2 feet in the Harwich case study area. Access to hydrants will be hampered at water surface elevations of 6 feet in Harwich. There is a risk of road washout, and damage to the water mains, at all three locations, with the Harwich and Orleans locations most exposed to wave actions. Damage to these water mains will cut off water supply to homes and hydrants. As sea level rises, increased corrosion can be expected, particularly at the Orleans and Harwich locations.

### 4.3 Wastewater Pump Station

The Harwich pump station is located in a cul-de-sac which will be inaccessible when water levels rise above 12 feet. Over-topping of the wet well and damage to the standby electrical generator will occur at water elevations above 13 feet. This station's location at the headwaters of Muddy Creek protects it against wave action.

### 4.4 Stormwater Treatment System

The existing stormwater treatment system at Lonnie's Pond in Orleans will be overtopped at water elevations over 5.5 feet. Impacts on the herring run will occur at elevation 4.5 feet.