Nahant Thicket Wildlife Sanctuary
Ecological Restoration and Maintenance Plan

Prepared by:

Mass Audubon's Ecological Extension Service

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Mass Audubon
Protecting the Nature of Massachusetts

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Introduction

Nahant Thicket Wildlife Sanctuary is one of Mass Audubon's smallest properties at 4.5 acres in size. Despite its modest size, the Thicket provides critical stopover habitat for migrating songbirds and is an important component of the Nahant Bay Important Bird Area. The property is a well-loved patch of greenspace for the neighborhood and larger community. In addition, as the low point for the surrounding watershed, the property serves to store storm water and surface runoff, ultimately draining to the sea under Willow Road.

Nahant Thicket was acquired by Mass Audubon in 1949 through a donation of land by Mrs. Richard Fay and Henry H. Perry as well as financial support by local residents and organizations. The acquisition was described in an article in the Bulletin of the Massachusetts Audubon Society in 1949 titled: *Maple Swamp Presented to Society*. The sanctuary was protected for its value as bird habitat, particularly during migration.

Despite Mass Audubon's regular maintenance of the property, there are several management needs at the Thicket. Invasive plant species have become dominant in some sections, parking is limited, the trails do not meet Mass Audubon's current standards for accessibility, and the town-maintained storm water drainage system does not always function as designed. This document proposes specific actions necessary to address these challenges, as well as best practices and strategies for ongoing management of the property in future years.

Restoration efforts will focus on three major goals: 1) vegetation management to enhance wildlife habitat and the visual appeal of the outer boundaries of the thicket; 2) addressing hydrological constraints that may contribute to localized flooding; and 3) improving the visitor experience through improved parking, signage, and trails.

This plan is the result of a true collaborative effort which included intensive study, multiple site visits, two public presentations and discussions with long-time neighbors, a volunteer work day, consultation with a professional hydrologist and a landscape architect, and detailed input from town staff. We have incorporated all of that information into the following plan to achieve our vision: a Nahant Thicket Wildlife Sanctuary that welcomes neighbors and visitors with an attractive, small parking lot; informative trailhead signage; and a solid and stable boardwalk extending throughout the property. A site that adds aesthetic value to the neighborhood, draws the eye, and brings a smile to those walking or driving past. A diverse mix of native vegetation that provides habitat for migratory birds and other wildlife. A local resources that residents frequent and are proud of.

General character and landscape context of Nahant Thicket Wildlife Sanctuary

Nahant Thicket Wildlife Sanctuary is a 4.5 acre property located in the Town of Nahant, a peninsula extending south from Lynn into Massachusetts Bay. The Thicket is one of the major parcels of undeveloped land in the densely developed Town of Nahant. The Thicket is in a residential area surrounded by Furbush Road, Willow Road, Walton Road and Wharf Street.

The Thicket has a 2 car parking area directly abutting Furbush Road. Access to the interior of the property is via an entrance at the southern end of Furbush Road, roughly 450 feet from the parking area, or from Wharf Street. A walking trail of about 1,000 feet bisects Nahant Thicket along a north/south axis. Roughly 250 feet of boardwalk carries the trail in wetter sections where exposed tree roots and watermarks on nearby tree trunks indicate regular inundation. The streets surrounding the

Thicket are very quiet. Visitors can easily cross Furbush and Walton Roads to connect to other conservation parcels managed by Nahant Preservation Trust. A sidewalk along Wharf Street creates pedestrian friendly access to the northern entrance to the Thicket.

Nahant Thicket Wildlife Sanctuary is within the Nahant Bay Important Bird Area. The sanctuary is popular with birders, especially during migration and in winter. During spring and fall Nahant Thicket acts as a critical stopover location for migrating birds, providing a feeding and resting place. In winter, with local temperatures moderated by the surrounding waters of Massachusetts Bay, bird species that typically spend the season south of Boston often linger in Nahant Thicket. The sanctuary also provides breeding habitat for a smaller number of bird species. The likely presence of predators such as cats, raccoons, and foxes, typically common in residential areas such as those adjacent to the Nahant Thicket, would have impacts on reproductive success of these breeders.

Topographically, Nahant Thicket Wildlife Sanctuary lies at the base of a shallow bowl, surrounded by higher land to the north, west, and east. As a result, the sanctuary receives storm water runoff and groundwater drainage from the surrounding residential neighborhood. Historic documents and photos show that the property was historically a red maple swamp and salt marsh, open to the sea, with a bridge carrying Willow Road over this opening. Conversion of Willow Road to a causeway across this opening, sometime early in the 20th century, has blocked tidal flow into the Thicket and hampers drainage out.

Goals for the use and management of Nahant Thicket

Nahant Thicket Wildlife Sanctuary is managed primarily as wildlife habitat to be experienced through a limited trail system. Passive uses such as walking, nature observation, photography, and educational programs are encouraged. Pets, motorized vehicles, fishing/hunting/trapping, and collecting items are not permitted. The property is also managed to contribute ecosystem services to the community, including storm water storage and flood abatement, noise reduction, visual screening, and opportunities for passive recreation.

Given the location and size of Nahant Thicket Wildlife Sanctuary we expect this destination to remain a treasured local gem in the Nahant community. Any restoration activities are assumed to lead to an increase in visitation from the local community and Mass Audubon members. A modest increase in visitation from new visitors is expected particularly from birding enthusiasts. We do not expect there to be a drastic increase in visitation that would cause local disturbances.

Current Conditions

The Thicket is an assemblage of Mass Audubon fee owned land as well as one parcel protected by Mass Audubon with a Conservation Restriction (CR). There are currently roughly 1,000 feet of trail, 250 feet of which run along wooden structures such as boardwalks, bridges, and steps. Three ditches run through the property, with two lateral ditches draining into a central ditch which runs to pipes underneath Furbush Road, eventually flowing into the ocean on the south side of Willow Road. There is a small parking area along Furbush Road that accomodates two cars (see Figure 1).

Vegetation

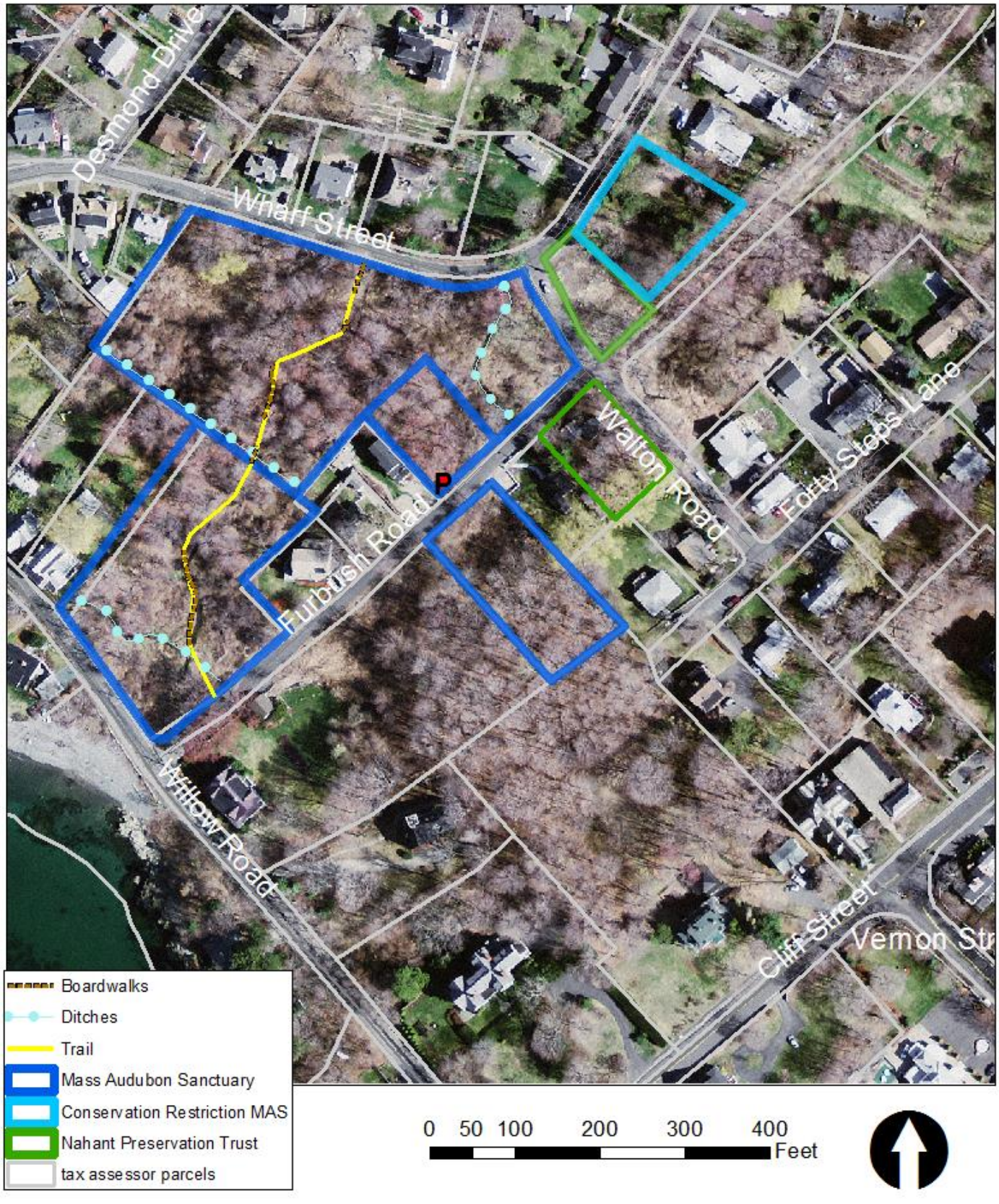
The sanctuary can be divided into three major cover types: Wet Meadow, Red Maple Swamp, and Shrub Thicket. The Wet Meadow areas are located in the southwest, northwest, and northeast corners of the property; the Red Maple Swamp dominates the central portion of the property and the parcel southeast of Furbush Road; while Shrub Thicket is characteristic of the meadow edges and roadside vegetation,

particularly along Willow and Furbush Roads. The Swamp and Wet Meadows of the main parcel are characterized and influenced by periodic inundation due to flooding.

The Red Maple Swamp is a wooded wetland dominated by red maple (*Acer rubrum*) with silver maple (*Acer saccharinum*), swamp white oak (*Quercus bicolor*), and American elm (*Ulmus americana*) also present. The understory is generally a dense tangle of common greenbrier (*Smilax rotundifolia*) and is heavily invaded by multiflora rose (*Rosa multiflora*). Northern arrow-wood (*Viburnum dentatum var. lucidum*), sweet pepper-bush (*Clethra alnifolia*), and common elderberry (*Sambucus nigra*) are also present. The overall condition of this portion of the property is good. The majority of the plants present in the canopy and understory are native species. Multiflora rose is an invasive plant.

The Wet Meadows are heavily invaded and degraded by non-native species. Each is dominated by two invasive grasses, common reed (*Phragmites australis ssp. australis*) and reed canary grass (*Phalaris arundinacea*). A few native wildflowers are found within each stand, including stinging nettle (*Urtica dioica*) and seaside goldenrod (*Solidago sempervirens*). The edges of each wet meadow are largely overgrown with invasive shrubs and trees. These dense edges create a visual barrier from the roadside, reducing what could be an attractive vista across these open sections of the property.

The Shrub Thicket is also largely dominated by invasive species. The most common are multiflora rose, Morrow's honeysuckle (*Lonicera morrowii*), winged euonymus (*Euonymus alatus*), common buckthorn (*Rhamnus cathartica*), and border privet (*Ligustrum obtusifolium*) – all invasives. While this section is heavily impacted by invasives, several native species are present and will provide a starting point for restoration. These native species include chokeberry (*Aronia spp.),* common elderberry, crack willow (*Salix fragilis*), American basswood *(Tilia americana*), black cherry (*Prunus serotina*), and horse-chestnut (*Aesculus hippocastanum*).



"This map is for planning purposes only. Boundaries are approximate.
THIS MAP IS NOT A SURVEY. "

Figure 1: Current Conditions of Nahant Thicket

Figure 2: Ecological Cover Types at Nahant Thicket

Figure 3: Distribution of the most common invasive plants at Nahant Thicket.

Invasive Species

Invasive plant species are common and widespread on the sanctuary (Figure 3). The most common invasive species are common reed (*Phragmites australis ssp. australis*), multiflora rose (*Rosa multiflora*), oriental bittersweet (*Celastrus orbiculatus*), and Japanese knotweed (*Polygonum cuspidatum*). Other invasive plant species present are Norway maple (*Acer platanoides*), sycamore maple (*Acer pseudoplatanus*), garlic mustard (*Alliaria petiolata*), dame's rocket (*Hesperis matronalis*), Morrow's honeysuckle (*Lonicera morrowii*), winged euonymus (*Euonymus alatus*), purple loosestrife (*Lythrum salicaria*), border privet (*Ligustrum obtusifolium*), and common buckthorn (*Rhamnus cathartica*).

Table 1. Summary of invasive plant species present in Nahant Thicket.

Species	Location and Abundance
Norway maple	A few individuals on higher ground along the sanctuary boundaries.
Sycamore maple	A few individuals on higher ground along the sanctuary boundaries.
Garlic mustard	A few individuals along the roads that bound the sanctuary.
Dame's rocket	A few scattered individuals along the roads that bound the sanctuary.
Goutweed	Small populations in southwest corner of sanctuary.
Morrow's honeysuckle	Scattered individuals in drier areas along the sanctuary boundaries and interior.
Oriental bittersweet	Common in drier areas, especially along the streets that bound the sanctuary.
Winged euonymus	Scattered individuals in drier areas, especially along the streets that bound the sanctuary.
Border privet	Scattered individuals in drier areas, especially at the south end of the sanctuary.
Purple loosestrife	Scattered individuals along the roads that bound the sanctuary.
Japanese knotweed	Several small stands on northwest side near the property boundary (Figure 3).
Common buckthorn	Scattered individuals along the streets that bound the sanctuary.
Multiflora rose	Dense thickets in many areas, especially along the trail in the interior of the sanctuary (Figure 3).
Common reed	Several stands occupy approximately one acre (25%) of the sanctuary (see Figure 3).

Wildlife

As an island of vegetation within the near-island of Nahant, the Thicket does not have a long list of common wildlife. However, the site is well known as habitat for migrating songbird species which are seen and documented regularly by birders. Butterflies and other invertebrates benefit in particular from the open field habitats on the outskirts of the property. Remnants of a large snapping turtle were found on one visit. Other common urban species such as raccoons, squirrels, chipmunks, cats, and foxes are assumed to utilize the property.

Hydrology

The property is located in a shallow valley surrounded by higher land to the north, west, and east, spilling out to the ocean to the south. As a result, the sanctuary receives storm water runoff and groundwater drainage from the surrounding residential neighborhood (Figure 4). The property is currently drained by a system of ditches and culverts ultimately draining to a stormwater pipe underneath Furbush Road which drains to the beach south of Willow Road (Figure 5).

Within the site, water is conveyed in three primary channels to Furbush Road:

Channel 1 -- A small ditch, approximately 8 feet wide and 1-2 feet deep located at the northeastern corner of the thicket. This channel receives stormwater outfall from Wharf Street and Walton Road,. and drains southwest for approximately 80 feet and then southeast for another 80 feet before entering a pipe under Furbush Road. This pipe presumably connects with the main stormwater line under Furbush Road.

Channel 2 -- A widened ditch running west to east through the center of the Thicket. This channel drains water from the western part of the property, flowing northwest to southeast before entering an underground pipe on the west side of the abutting property at 18 Furbush Road. We presume that the underground pipe connects the stormwater pipe under Furbush Road. Although this channel has been maintained in the past for mosquito control, it is fairly vegetated now and retains puddled water. A grate at the downstream end of the channel becomes tends to become clogged with debris which also backs up water into the ditch.

Channel 3 -- At the southwestern end of the site, water drains through narrow swales less than one foot in depth before entering a pipe that we believe connects with the main stormwater system under Furbush Road. Field observations indicated that the pipe leading to Furbush Road is broken and may need repairs.

The pipe under Furbush Road carries water south under Willow Road and outlets to the ocean through an 18” pipe visible on the beach at low tide. The pipe is underwater at high tide, and very high tides and storms can cause seawater to rise higher than the lowest ground in the Thicket. To prevent flooding of the site by seawater, a flap gate was installed (accessed via a manhole on the seaward side of Willow Road) which is designed to allow stormwater to exit into the ocean while preventing ocean water from entering the pipe system. The outlet can become partially filled with sand and gravel due to wave action, which can slow or prevent drainage of the entire system. Town staff periodically clear these blockages from the outlet.

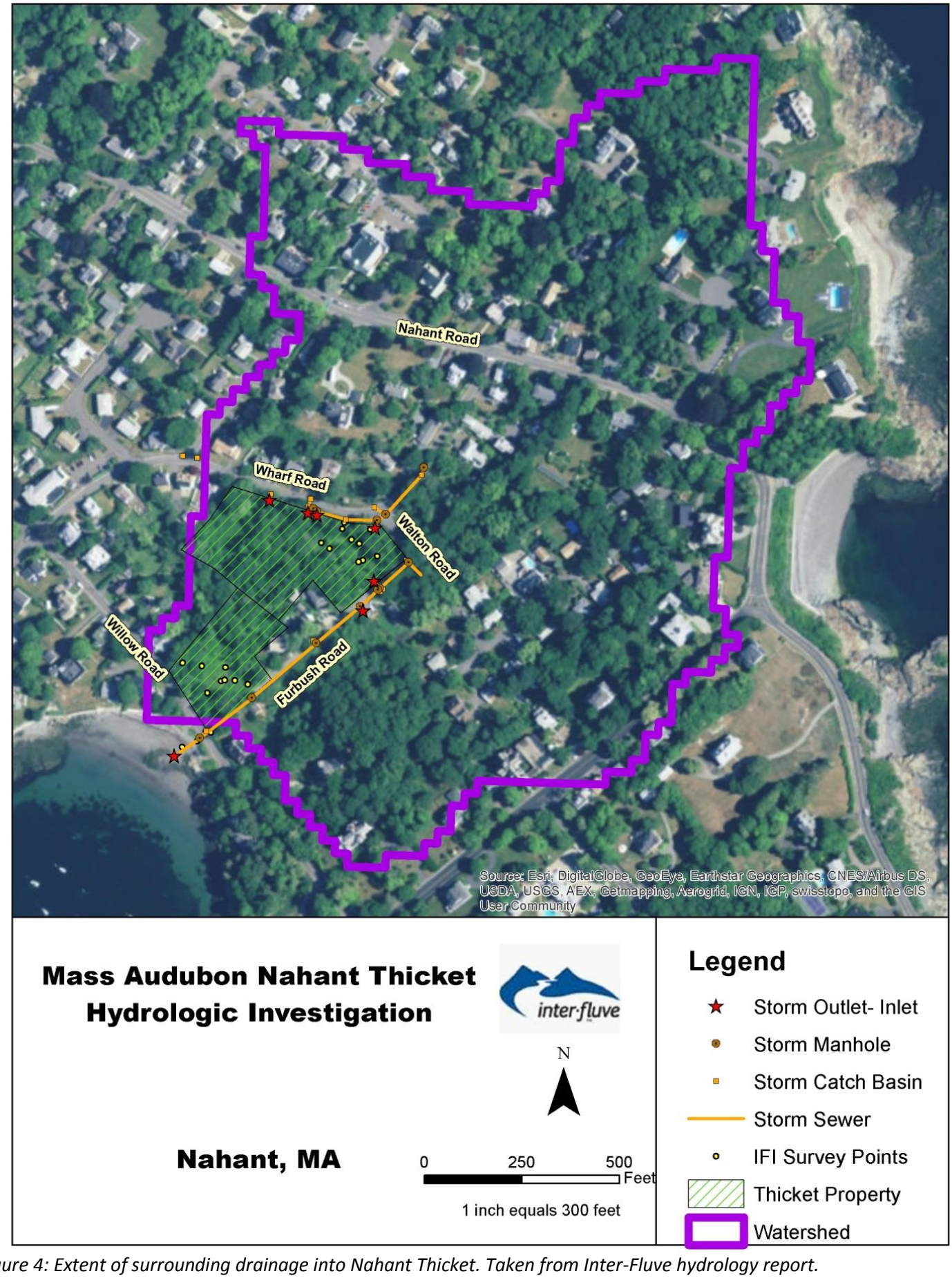


Figure 4: Extent of surrounding drainage into Nahant Thicket. Taken from Inter-Fluve hydrology report.

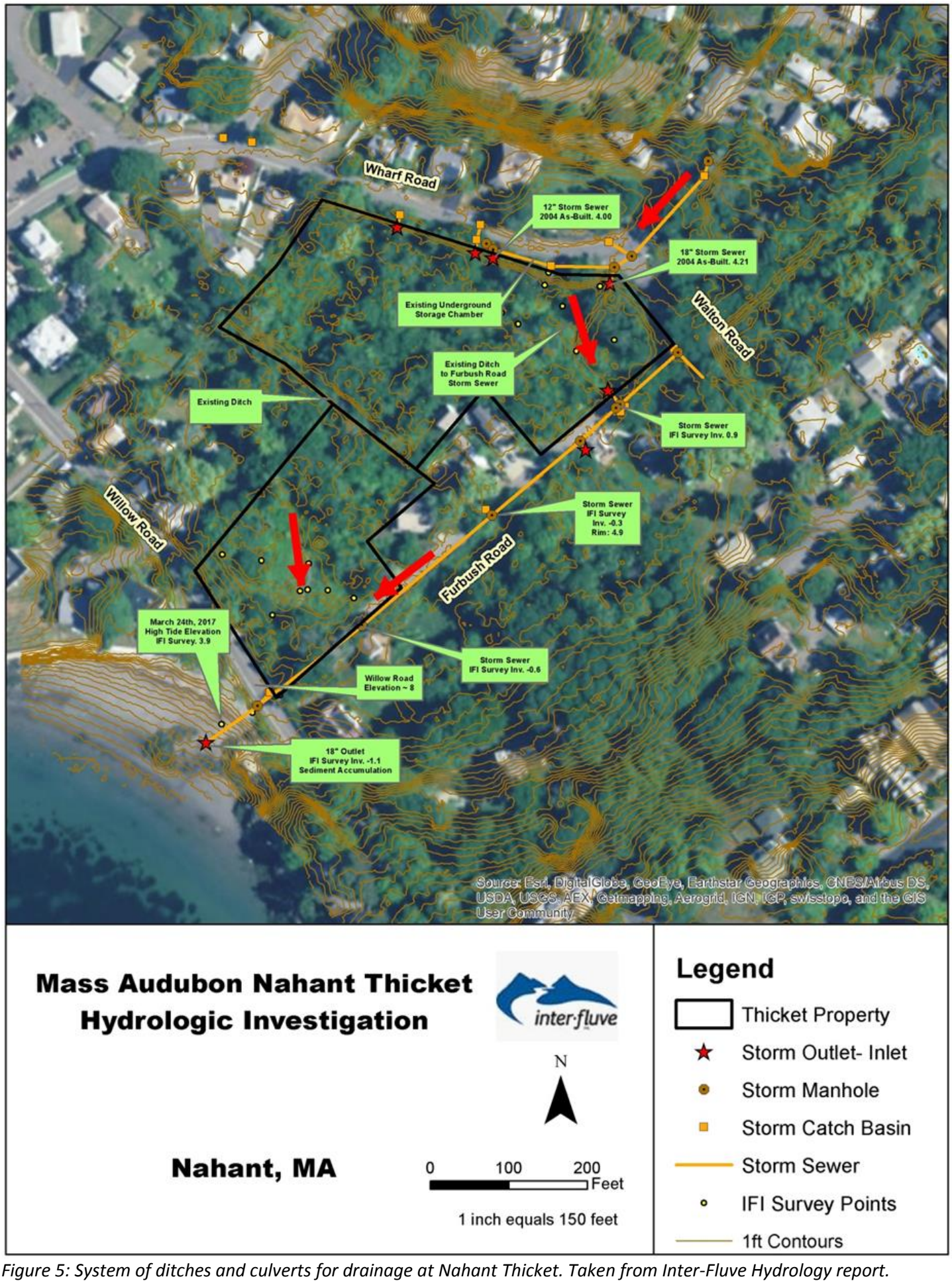


Figure 5: System of ditches and culverts for drainage at Nahant Thicket. Taken from Inter-Fluve Hydrology report.

Parking

Parking currently consists of two narrow, unsurfaced spaces directly abutting Furbush Road, adjacent to #18 Furbush Road (Figure 6). These spaces are relatively shallow and will comfortably accommodate only smaller vehicles. A small Mass Audubon parking sign indicates the parking spots. There is no trailhead at the parking area; visitors must walk either south along Furbush Road to the southern trail outlet or north on Furbush to Walton and Wharf to the northerly trail.

Trails

A relatively narrow trail consisting of dirt surface and sections of boardwalk stretches approximately 1,000 feet from the southeast corner of the property on Furbush Road to the northern side of the property on Wharf Street (Figure 7). The trail includes roughly 200 feet of wooden boardwalks and a wooden bridge across the largest drainage ditch on the property (Figure 8). The trail includes three wooden steps up to Wharf Street and the boardwalks and the bridge require stepping up from and down to the dirt trail segments. The bridge is not of the most stable design and gaps at either end require a mindful step when going from the bank to the bridge.

Figure 6: Parking on the North side of Furbush Road

Figure 7: Existing trail conditions for the main trail.

Figure 8: Bridge over central ditch.

Proposed Restoration

Restoration efforts will focus on three major goals: 1) vegetation management to enhance wildlife habitat and the visual appeal of the outer boundaries of the thicket; 2) addressing hydrological constraints that may contribute to localized flooding; and 3) improving the visitor experience through improved parking, signage, and trails. A re-routed trail that follows a reduced grade made of boardwalk will increase accessibility for users of all ages and will reduce soil impacts during periods of high water.

Figure 9: Map of Proposed Restoration areas.

Vegetation Management

Vegetation management will focus on enhancing wildlife habitat and improving the visual appeal of the site, particularly from the external perspective (Figure 9). We will reduce the presence of invasive plants, replace invasives by planting native shrubs, supplement existing Wet Meadow vegetation with additional wildflowers, and manage woody and herbaceous vegetation along the road frontage to present a more aesthetically pleasing aspect to the sanctuary exterior.

Invasives management and removal of select exterior trees will represent a notable change in vegetation density and structure. In order to avoid an undesirable impact on wildlife utilizing the thicket, this work will be carried out in three phases over multiple years (Figure 10). Thus as the newly planted native shrubs take hold in the Phase 1 area, we will move on to removing invasives and planting more shrubs in the Phase 2 area, etc.

Invasives Management

Non-native invasive species are those species which have been introduced to North America as horticultural specimens or accidentally and which, due to some combination of reproductive and ecological traits, are able to aggressively outcompete native plant species. Multiflora rose, glossy buckthorn, oriental bittersweet, common reed, Japanese knotweed, and Norway maple are just a few examples. Given the right conditions, these plants will grow at high density, spread rapidly, and aggressively resist efforts to remove them. Unfortunately, our native wildlife have not evolved with these introduced species, so the plants take up space while providing little in the way of habitat value. By displacing our native plants, invasives degrade habitat for the full range of native animal species.

We will reduce the cover of invasive species through a combination of manual, mechanical, and chemical control. Manual control involves simply pulling up plants. This can be a good activity for volunteer work parties. Mechanical control involves the use of machinery to cut or pull plants and can be carried out by Sanctuary Staff. Chemical control would mean the use of carefully applied herbicide to target the most aggressive species and would require management by either Sanctuary Staff or a Contractor. Mass Audubon's Invasive Species Management Policy recognizes the use of herbicides as an acceptable component of invasives management program when carefully planned and carried out by a licensed herbicide applicator.

Complete eradication of invasive species is often not a realistic management goal primarily due to the existing seed bank and surrounding vegetation. Instead, the focus is primarily on keeping invasive species balanced with native species within the landscapes so a mosaic of vegetation is present instead of a dominating monoculture. When treating invasive species an 80% efficacy is generally considered successful treatment.

The most intensive invasives management will involve removal and chemical treatment of shrubs in the interior of the property. As discussed above, this work will be phased and coupled with native plant restoration to minimize impacts on native wildlife. Treatment of invasive shrubs will also be an integral component of work to create a new parking lot, to re-route trails, and to restore or relocate drainage ditches. We project that this work would require multiple years of follow-up treatment in each area to prevent resprouting and reestablishment of invasives.

Habitat Enhancement

Treatment and removal of invasives from the areas where they are currently growing in dense patches will leave behind significant openings in the shrub layer. We will actively restore these sections by planting native, fruiting shrubs and small trees that are appropriate for the growing conditions. Potential

species include dogwoods (*Cornus* spp.), viburnums (*Viburnum* spp.), high bush blueberry (*Vaccinium corymbosum),* common elderberry, shadbush (*Amelanchier* spp*.)*, tupelo (*Nyssa sylvatica),* and Virginia creeper (*Parthenocissus quinquefolia*). Plantings will be selected and located to provide adequate vegetative structure and density for use by spring migrating birds – we will aim to retain the function and feel of *the Thicket*.

Existing vegetation in the Wet Meadows near the northeast and southern ditches will be supplemented with a mix of native seeds designed to provide food resources for pollinators and invertebrates in general. The seeds will be a mixture of annual and perennial flowering species and grasses, with different bloom times throughout the year. The mix will be designed to provide habitat for a wide range of pollinators (Appendix A) and will also provide visual appeal from the roadside. A deliberate planting of short grasses such as little bluestem along the boundaries of the wet meadows will provide a symbolic border for the property. The low lying vegetation will maintain a scenic vista into the property while also indicating a defined boundary.

Vegetation Management along Road Frontage

As with any forested area managed primarily for wildlife habitat, Nahant Thicket contains trees at all stages of their life cycle, from young saplings to declining canopy trees. These declining trees, with their soft deadwood limbs and invertebrate decomposers, provide important feeding and nesting habitat for a wide range of wildlife. However, these trees can also represent hazards to infrastructure and visitors due to their structural instability and can contribute to an 'unkempt' appearance. We propose selective removal or trimming of specific trees on the exterior of the property, primarily non-native species, while maintaining most interior trees in various state of growth, decline, and decay. In future, the exterior trees will be managed periodically to avoid hazardous conditions as well as to provide a tidier appearance to those passing by the sanctuary.

The first phase of tree removal will involve removal of roughly half the trees along the perimeter in the northeastern corner of the property, including the eastern end of the Wharf Street boundary and the boundary along Walton Road (see Figure 10). This management effort will be the most aggressive visually and will primarily serve to remove non-native species and dead, declining, or poorly formed trees and to restore vistas into the wet meadow. Norway and Sycamore Maples will be removed while desirable native species such as crack willow, American basswood, and horse-chestnut will be retained. These remaining trees will be given more space to grow in a natural form rather than in their current, crowded form.

Moving west along Wharf Street, a more selective removal process will take place during phase three of vegetation management (Figure 10). As this stretch of the boundary features more native trees and fewer invasives, we will focus on removing the invasives so natives in the understory have the opportunity to flourish. Species such as Norway maples will be removed, releasing several smaller individuals of American basswood, black cherry and horse-chestnut. This more selective removal approach will favor the growth of native species as well as maintain the wooded edge of the property. Removing these mature invasive species will also prevent these species from recolonizing restored areas of the sanctuary.

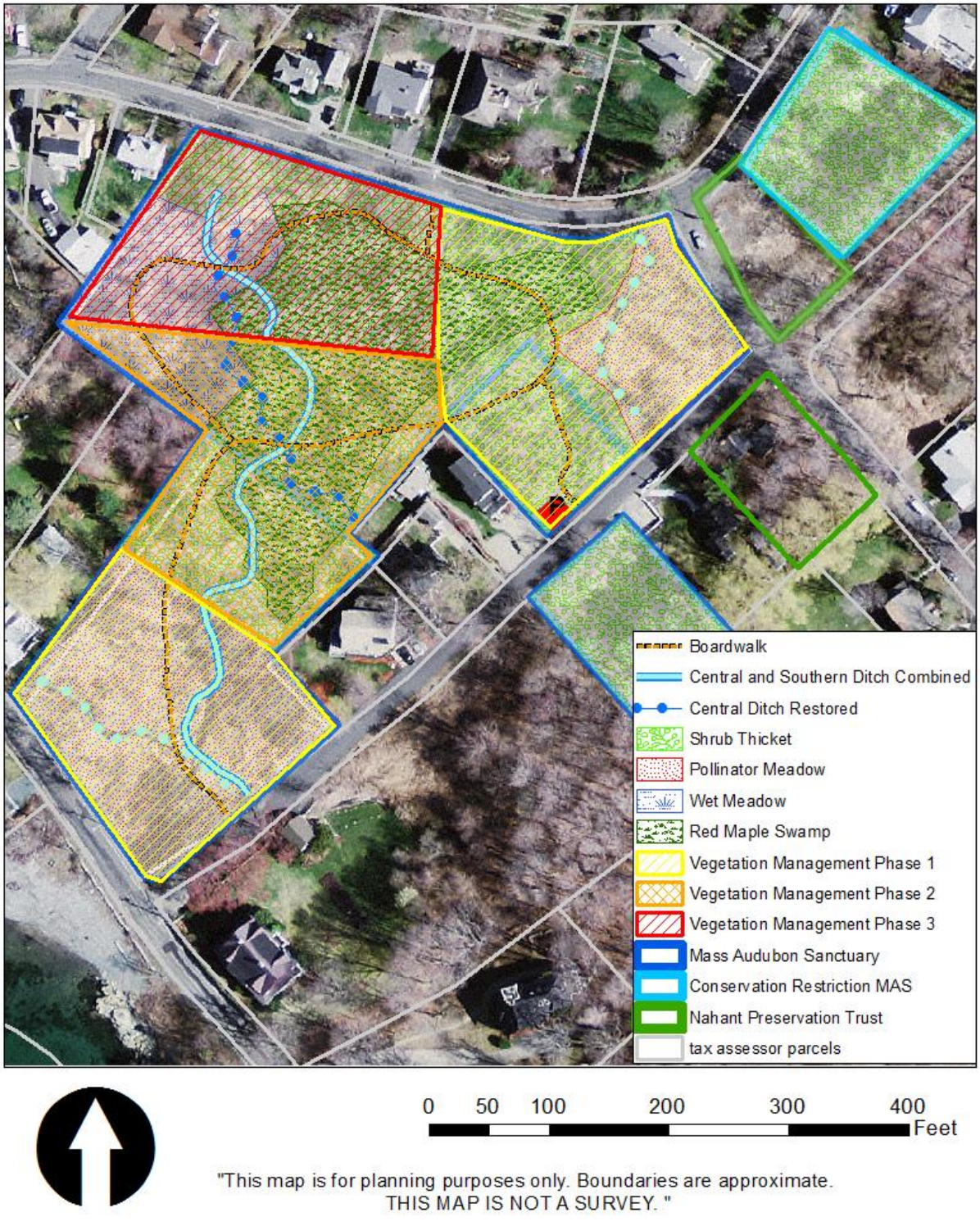


Figure 10: *Vegetation Management will be conducted in phases and opportunistically with installation of boardwalk and ditch restoration so that no one entire habitat type is treated at the same time.*

Table 3: Proposed timeline for vegetation management

Activity	Timeframe	Entity
Permitting	September 2017- March 2018	Mass Audubon Staff
Tree Removal	March- May 2018	Contractor/ Mass Audubon Property Staff
Invasive Plant Management Phase 1	August 2018- Oct 2018	Contractor
Wet Meadow Restoration	Oct- Nov 2018	Mass Audubon EES staff/ Regional Scientist/ Property Staff
Invasive plant Management Phase 2	May 2019- May 2020	Contractor
Invasive Plant Management Phase 3	May 2021-Nov 2021	Contractor
On-going Invasive Plant Management	Annually/ as needed	Mass Audubon Regional Scientist/ Property Staff
On-going Tree Management	As needed	Mass Audubon Property Staff

Visitor Access

Parking

Our goal is to improve the existing parking area on Furbush Road to provide a more spacious and attractive point of arrival for sanctuary visitors (Figure 7). We will expand and regrade the parking area, improve surface grade and drainage, and slightly increase the size of the lot ideally including at least one space designated for handicapped use. The first step is to excavate a 6-8 inches of topsoil from the existing lot and replace with a gravel base and fine-gravel top layer to create a firm and well-drained surface. The lot would be level and flush with the road edge. A small amount of fill may be necessary to extend the parking lot a bit to the north, to accommodate 3 parking spaces. Each of the 3 spots would be marked with a concrete or stone parking bumper. We would also install a screen of vegetation at least 7 feet tall on the southwestern side of the parking lot to provide privacy for the neighbors.

It is important to note that increasing the amount of parking at the existing location would require adding a small amount of fill, on the north side of the current spots, to bring the adjacent ground up to the level of Furbush Road. As the entire area is subject to flooding and within the wetland buffer or wetland, this fill would likely be determined to represent a reduction in flood storage capacity for the site and is generally not a project supported by a Town's Conservation Commission. Such an impact can be approved by the Conservation Commission if flood storage capacity is *increased* in another part of the property. We would propose to meet this requirement through the regrading of the existing drainage channels. By regrading these channels our hope would be to increase the overall flood storage capacity of the site. This would not only help with flooding issues within the sanctuary but also offset any perceived decrease of flood storage capacity due to the use of fill for expanding the parking area. If

the Conservation Commission is reluctant to approve this approach, parking may need to remain limited to the existing two small spots.

We pursued conversations with the Nahant Preservation Trust regarding creation of a joint parking lot on their newly acquired 'Burke Lot' located at the corner of Furbush and Walton. Unfortunately, given the way the property was acquired – via town auction after a tax title taking, with the stipulation that the land be reserved for open space – parking is not a feasible use of that property. Likewise, we investigated the potential of creating parking on the small Mass Audubon parcel on the eastern side of Furbush Road. The land on this side of the road drops down immediately from Furbush Road by a foot or so, which would require the addition of fill to make level parking spaces. As discussed above, such fill would likely be determined to be reducing flood storage capacity on the lot and would need to be made for elsewhere on the lot. Given the grades of this lot, with very limited wetland conditions found only directly adjacent to the road, such accommodation would not be possible elsewhere on the site. For this reason, we have concluded that parking would not be feasible here.

We will work with colleagues to design and install standard Mass Audubon sanctuary signage that would welcome visitors, indicate the access points and trails into the Thicket, and clearly state that parking is not permitted for beach access. A welcome kiosk will provide background information about the Thicket, information about the trail system and safety risks such as poison ivy and ticks. A similar lot at our Rough Meadows Wildlife Sanctuary in Rowley is shown in Figure 11 and typical signage is shown in Figure 12.

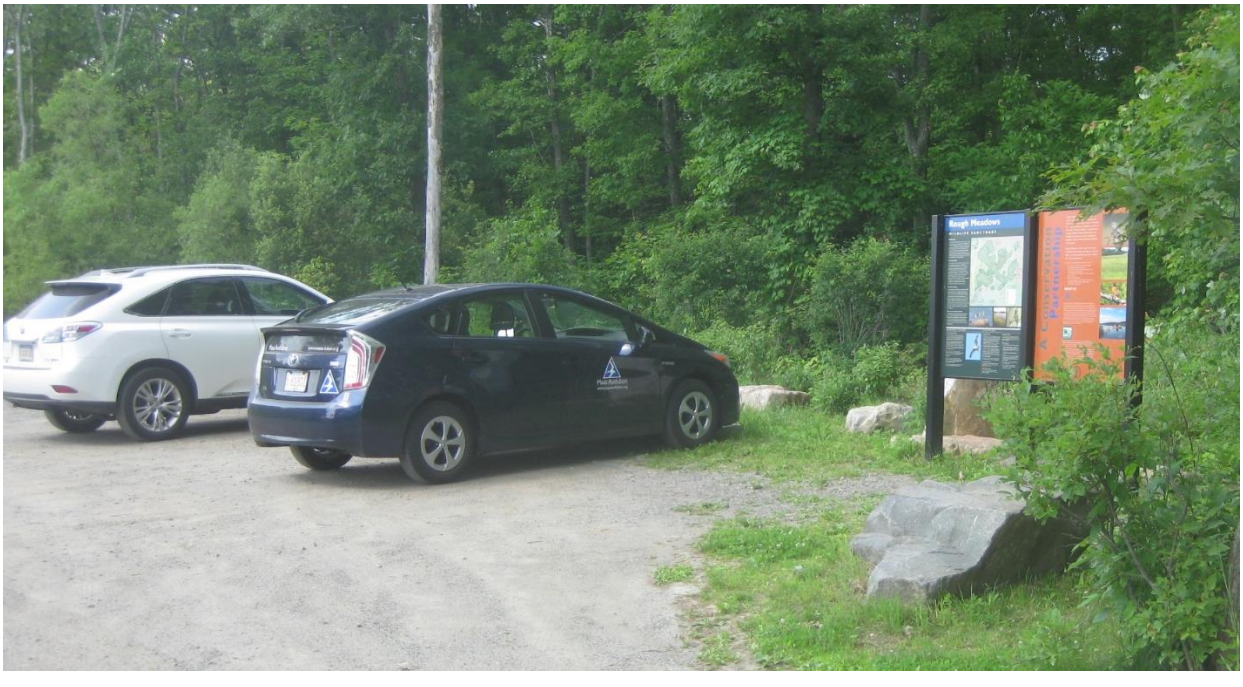


Figure 11. An example of a gravel lot with granite stone parking bumpers, Rough Meadows Wildlife Sanctuary, Rowley.

Figure 12. Example of informational signage at Rough Meadows Wildlife Sanctuary, Rowley.

Trails

Trail improvements will focus on enhancing accessibility for a wide range of users while maintaining the low-impact, subtle character of the current trails. The entire, 1,000-foot length of trail will consist of 5-foot wide boardwalk standing roughly one foot above the ground. A full boardwalk will provide level footing along the entire trail for users of all abilities, will permit access to the trail during times of flooding, and will allow vegetation to re-grow along the existing trail to reduce erosion. A new section of trail will lead from the parking area through the wet meadow on the northeastern corner of the property and on to the existing entrance from Wharf Street. The trail will continue in a large loop through the northern half of the property with a spur leading south to the current Furbush Road entrance.

The boardwalk will use a modern design that we employed for the Red Maple Trail in partnership with U.S. Fish & Wildlife Service at the Great Meadows National Wildlife Refuge in Sudbury (Figure 13). This method makes use of metal posts augured into the soil, holding the boardwalk structure above the moist ground and involving minimal disturbance of soil. We will trim vegetation modestly, to ensure a clear walking path.

Although more costly than a dirt trail, a boardwalk will involve much less disturbance to the site and will be longer lasting and a better, more accessible surface for all users.We explored the concept of a gravel or stone dust trail which would involve clearing vegetation to about 6 feet in width, excavating four to six inches of subsoil, then installing landscaping fabric, a crushed stone base, and a fine stone dust surface. We rejected this alternative due to the extent of soil disturbance necessary, the need for heavy equipment on-site, and the fact that site hydrology would make the trail prone to flooding and necessitate costly ongoing maintenance.

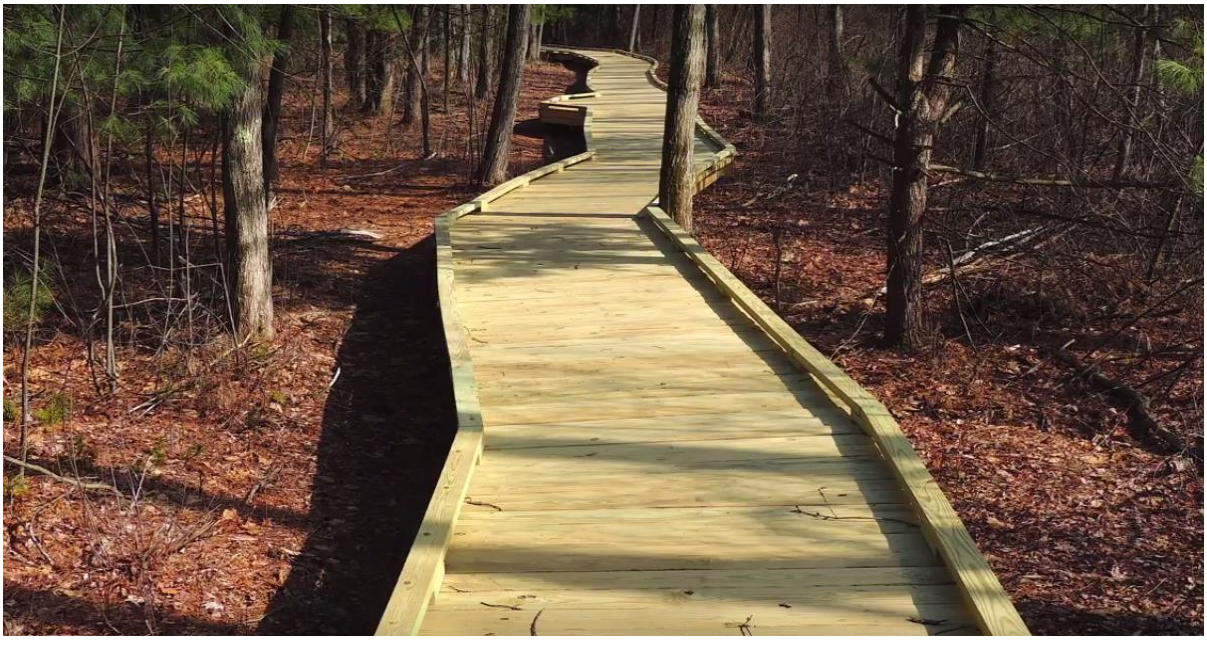


Figure 13. Raised boardwalk at Great Meadows NWR, Sudbury.

Table 4: Proposed timeline for visitor access

Activity	Timeframe	Entity
Permitting	September 2017- March 2018	Mass Audubon EES Staff
Purchase supplies for parking area and boardwalk	March- May 2018	Mass Audubon EES Staff
Hire contractor for parking area and boardwalk	March- May 2018	Mass Audubon EES Staff
Flag out boardwalk and parking area locations	March- May 2018	Mass Audubon EES Staff
Fill and grade parking area	May- September 2018	Contractor/ Mass Audubon Property Staff
Design, order and install signage	August- November 2018	Mass Audubon Education and Property Staff
Install boardwalk	May 2018- May 2019	Contractor
On-going maintenance of parking area, replace signage, trim vegetation	Annually/ as needed	Mass Audubon Property Staff
On-going maintenance of boardwalk; replacing boards	As needed	Mass Audubon Property Staff

Hydrology

We worked with hydrologists from Interfluve, Inc. to characterize hydrology at Nahant Thicket, identify deficiencies in site drainage, and propose ways to alleviate flooding at the site. Field investigations, our own knowledge of the site, and neighbor experiences indicate that the property is periodically inundated and that the flooding is primarily a result of stormwater not draining from the site and occasional seawater intrusion into the site. In addition to collecting field data, we also met with staff of the county mosquito control agency, the town Department of Public Works (DPW), and our hydrologist to discuss hydrological management of the Thicket. We discovered that the current infrastructure (town-owned pipes designed to drain stormwater from the Thicket into the sea) has not been flushed in about 10 years which may be causing the majority of the drainage issues at the site. Our hydrologist also observed bricks in one of the pipes under Furbush Road which may indicate the drainage pipe from the central ditch may have structural damage and is collapsing.

The flooding is likely a combination of a few factors:

- The town-owned stormwater system which drains water from the Thicket to the sea has not been flushed in several years, and a component of the pipe system may have been crushed at some point.
- The outlet pipe on the beach is periodically blocked by sand and gravel debris which prevents drainage from the Thicket.
- The frequency and intensity of extreme precipitation events has increased in New England, due to climate change.

- Increased impervious surface in the watershed that drains to the Thicket translates to more stormwater runoff reaching the Thicket.
- Stormwater cannot drain from the site during high tides. A series of very high tides will act to prevent water from ``effectively draining from the Thicket for a longer period.

Based on the Interfluve analysis and follow-up conversations with neighbors as well as current and former town staff, we generated the following three alternatives for improving drainage from the Thicket:

Option 1: Regular Maintenance of Storm Sewers with Minor Modification

According to a former town engineer and a long-time neighbor, the stormwater pipes are old and have not been regularly maintained in recent years, with the last power flushing of the pipes 10-15 years ago. During the site visit, trash and debris were observed covering all pipe inlets as well as within the upstream manhole, and sand and gravel were blocking the outlet of the pipe on the beach. With regular, possibly seasonal, maintenance that includes the removal of blockages from all inlets and a power flushing of the pipes, the functionality of the current stormwater system could be improved. In addition, a check valve such as the Tideflex Check Valve (Figure 14) could be added to the outfall pipe on the beach. This device would prevent accumulated sand and gravel from blocking drainage.

These steps would likely reduce some of the unwanted flooding that occurs on the site, but additional engineering review of the pipe capacity and existing underground storage system is recommended to quantify the effects of these potential improvements. This alternative would not solve the problem of flooding that occurs when high tides prevent the flood waters from leaving the site.

Cost: This is a lower capital cost option, but requires ongoing maintenance cost and commitment by the Town.

Figure 14: The TF-1 Tideflex Check Valve, an alternative to the existing flap gate.

Option 2: Stormwater Storage Under Roads

One way of storing stormwater before it enters the Thicket is to design and construct storage units under the adjacent roads similar to what was done near the intersection of Wharf Road and Walton Street. This would require removing the existing road subgrade, installing storage units, and then repaving the roads. This alternative would allow for some storage of stormwater received from the upper portions of the watershed that could then be released more slowly through the Thicket and to the ocean. This option could include the replacement of the existing flap gate with the Tideflex valve to reduce potential for backflow from the ocean. This option may reduce internal flooding during high tailwater conditions (e.g. during high tides) up to designed storm events.

Cost: This option would require high capital cost for placement of storage units and coordination and collaboration with the Town and surrounding community. It would also require long-term maintenance commitment by the Town to remove obstructions that may reduce effectiveness and regularly flush or vacuum debris from the underground storage system (approximately twice per year).

Option 3: Restoration of Tidal Connection Underneath Willow Road

This alternative would involve re-activating the tidal fluctuations within the Thicket by connecting the site to the ocean through an opening under or through Willow Road. Restoring the tidal fluctuations would result in the greatest visual changes to the site, but would also likely result in the least amount of long-term maintenance. Two options for creating this connection include:

1) Partially removing Willow Road to allow water to flow back and forth between the ocean and the Thicket within a natural channel. The current road network maintains continued access to houses on either side of this opening, which would allow Willow Road to be partially removed without eliminating resident access. A pedestrian bridge could connect the two sides if desired.
2) Placing a box culvert under Willow Road to allow water to flow under the road while maintaing vehicular access.

In both of these scenarios, the current system of stormpipes under Furbush Road would remain intact and would convey stormwater as needed. However, the water elevations with the project site would rise and fall with the tides. Because of the low elevation, portions of the site would likely consist of tidal marsh grasses, while other areas may contain woody vegetation. This regular tidal flushing could provide natural mosquito control as well as invasive plant control. The existing inlet connections from the Thicket to the stormsewer would be blocked, since the Thicket would drain directly to the cove. As with previous options, a Tideflex valve could be installed to replace the current flapgate to improve the stormsewer functionality, but would provide less value to the Thicket property under this option.

This last alternative would reduce stormsewer maintenance needs, since vegetation and debris from the Thicket would no longer drain into the system. The stormsewer would continue to serve its primary function of draining the roadway, and would require some maintenance from the Town at the beach discharge point, but this outlet clogging condition would no longer impact the Thicket property. In analyzing the data maps from the Town, utilities (water and stormsewer) pass under Willow Road. With this alternative to create a gap in the road, these utilities will need to be further analyzed to determine the best approach to maintaining continuous utility access. Additional evaluation of the tide range and confirmation of high-tide

flood extents within the Thicket and adjacent properties and roadways with additional survey would be necessary before furthering this concept.

Cost: The capital cost of this option could vary widely depending on the alternatives selected relative to Willow Road, but would be less than Option 2 and more than Option 1.

After assessing these three alternatives in collaboration with residents, town staff and others, we recommend pursuing the first option in the near term while continuing field investigations to better understand the potential for increasing on-site flood storage capacity and improving performance of the drainage ditches. The third option was determined to be undesirable as future high tides and storm tides may rise to levels that would put neighboring properties at risk.

To further enhance drainage, and in the context of the larger site restoration, we also propose to regrade and restore the drainage ditches within the Thicket to speed drainage from the property and to create a more natural character. We will need to work with Inter Fluve in the field during the summer and fall of 2017 to determine if the central and southern ditches can be regraded and combined into one large meandering ditch. If restoration and regrading into one ditch isn't suitable, we will focus on restoring the central ditch.

As each of the three alternatives presented above relies heavily on changes to the current town-owned infrastructure, communication among the various parties will be key to a successful outcome. Mass Audubon, the Town DPW and North East Massachusetts Mosquito Control and Wetland Management District (NE Mosquito) staff have established good lines of communication and will continue to work toward finding a solution to the current flooding issues, maintaining current infrastructure, and potential restoration projects to increase efficiency of the drainage ditches in the Thicket.

If drainage is still an issue at the site after the current infrastructure is flushed and ditches restored, the town has agreed to look into installing a pump at the corner of Willow and Furbush Roads and changing the flapgate under Willow Road. The pump will be similar to one the DPW recently installed near the golf course on the western side of Nahant, and all costs and maintenance would be the responsibility of the town. A proposed timeline of activities in below.

Table 5: Proposed timeline for hydrology improvements

Activity	Timeframe	Entity
Flush current infrastructure	July- September 2017	Town DPW
Inspect pipe with remote camera to look for structural damage	July- September 2017	Town DPW
Collect field data for regrading of ditches	September- November 2017	Contractor
Permitting	September 2017- March 2018	Mass Audubon EES Staff
Mark path for ditches	March- May 2018	Contractor/ Mass Audubon EES Staff
Ditch Restoration	October 2018- June 2019	Contractor/ NE Mosquito
Restore banks with vegetation	March- May 2019	Contractor/ Mass Audubon EES Staff

On-going clean out of ditches	Annually/ as needed	Mass Audubon Property Staff/ NE Mosquito
On-going flushing of infrastructure	Every 1-2 years	Town DPW

Maintenance of Nahant Thicket Wildlife Sanctuary

Staff from our Ipswich River Wildlife Sanctuary in Topsfield are responsible for maintenance of Nahant Thicket Wildlife Sanctuary. Carol Decker, Sanctuary Director, and Richard Wolneiwicz, Property Manager, will supervise ongoing maintenance of the parking area, signage, trails, and overall appearance of the property, as well as community coordination activities. Evan Marshall of our Land Protection Department will coordinate annual boundary walks to ensure signage is in good shape and boundary lines are being respected and maintained.

Ecological Monitoring

Habitat restoration necessarily involves a process of *adaptive management* in which regular monitoring informs management actions to ensure attainment of a desired outcome. In the case of Nahant Thicket, our Regional Scientist, Robert Buchsbaum, will coordinate efforts to monitor for re-infestation by invasive plants, the success of our planted shrubs and wildflowers, and for the response by birds, butterflies, and other species. These surveys will inform actions necessary to maintain the restoration and to further enhance the site.

Invasive Plants

After intensive invasive treatment by contractors, the sanctuary staff will continue to manage invasive plants on the property. The goal would not be eradication of all invasives, but rather keeping the relative abundance of invasive species to an acceptable level. These management activities will depend on the species being targeted and the time of year for treatment. The range of methods will be used include hand-pulling, mechanical, and chemical control.

Recommended invasives treatment will include manual control of species such as garlic mustard and dame's rocket. These manual efforts could include volunteer effort. However the most problematic species, including Japanese knotweed, common reed, and multiflora rose, will necessitate the judicious use of herbicides. Mass Audubon permits the use of herbicides on our wildlife sanctuaries according to a Pesticide Use Policy. Each application is approved only in the absence of other feasible methods for controlling the target plants. Some other species will be treated with a combination of mechanical, manual, and chemical means.

Invasive plants that have been hand pulled or cut and do not contain fruits will be piled or chipped and dispersed on site to decompose. All other plants will be bagged and hauled away either by sanctuary staff or by coordinating with the local DPW. Staff and volunteers will exercise extreme care to avoid spreading seed or other material from which plants can re-sprout; e.g., garlic mustard can continue to

flower and seed after it has been pulled. Species that are easier to manage by mechanical or manual efforts will be treated by volunteer groups including the local community and high school.

Table 6: Season-specific Management for Commonly Found Invasive Plant Species at Nahant Thicket.

Common Name	Spring	Summer	Fall
Border Privet			chemical
Burning Bush	manual		chemical
Bush honeysuckle	manual	chemical	
Common Buckthorn	manual		chemical
Common reed			chemical
Dame's Rocket	manual	manual	
Garlic mustard	chemical/manual		
Goutweed		manual	
Japanese knotweed		chemical	
Multiflora rose	manual	chemical	
Norway Maple			chemical
Oriental Bittersweet	manual		chemical
Purple loosestrife		biological	
Sycamore Maple			chemical

Boundary Stewardship

Boundaries will be inspected a minimum of once per year by Mass Audubon staff. We will install and maintain clear boundary signs and establish and maintain open communication with abutters to minimize the risk of encroachment.

Proposed Schedule of Annual Maintenance Activities

Table 7: Annual Maintenance Activities

	MAS position	Winter Dec- Feb	Spring Mar- May	Summer Jun - Aug	Fall Sep- Nov
Property Visits	Property Staff	3-6	5-7	6-9	5-7
Permitting (boardwalk, invasive control, etc) as necessary	Regional Scientist	X			
Annual Work Plan Review Meeting with Staff and Stewards	Sanctuary Director	X			
Work plan and maintenance meetings for hydrology with NE Mosquito and town DPW annually or as necessary	Property Staff/ Regional Scientist	X			
Safety Meeting with Staff, Stewards (plus Police and Fire Dept. as necessary)	Sanctuary Director		X		
Trail Walk/Clean Up (downed limbs, drainage issues, signage needs, plow damage)	Property Staff		X		
Ecological Monitoring	Regional Scientist		X	X	X
Invasive Plant Management	Property Staff/ Regional Scientist	X	X	X	X
Building Projects (kiosks, sign posts, repair boardwalks, etc.)	Property Staff		X	X	X
Boundary monitoring for encroachments, signage, etc.	Land Protection	X			X
Year-in-review meeting with Staff and Stewards	Sanctuary Director	X			

Partnerships

Maintaining current partnerships and building new relationships within Nahant will be critical to the near term success of any restoration efforts and the long-term sustainability of these efforts. We have established strong connections with town government, neighbors, and conservation colleagues in town and look forward to further engagement throughout the planning and implementation process. Key partners include:

- Neighbors – Our public engagement meetings on March 9th and May 2nd, 2017 were each attended by roughly 40 neighbors and friends of the Thicket. Several attendees enthusiastically offered to assist with property restoration, clean up and maintenance. We collected email contact information and will be following up with attendees to plan a follow-up meeting and to engage them in volunteer activities.
- Mass Audubon Volunteers- On April 29th we hosted our first Mass Audubon sponsored 'Work for Wildlife' day for Nahant, which was attended by several members of the community.
- Town of Nahant – Current and former staff have already been key in understanding site hydrology and design of the drainage infrastructure. Our hydrologist will continue to work with town staff to propose remedies that will enhance site drainage. We will work closely with the Conservation Commission and potentially the Building Inspector to review and permit various proposed activities.
- Nahant Preservation Trust – NPT has acquired the former Burke Lot at the corner of Walton and Furbush Roads and is interested in consulting with Mass Audubon to restore the property. We will work closely with the NPT board to explore integration of our restoration planning with their planning for the Burke Lot.
- Nahant SWIM – Leaders of this local environmental protection organization have offered to coordinate volunteer efforts at the Thicket. We have been in contact and will be working to plan a spring cleanup at the Thicket.
- North East Massachusetts Mosquito Control and Wetland Management District – Mass Audubon staff have met with NE Mosquito staff to discuss maintenance of the drainage ditches on the Thicket. The District has offered to assist with ongoing maintenance.
- Birders – We will continue to reach out to birders as one of our most important user groups at the Thicket. These constituents will provide us with their perspective on habitat needs, the visitor experience, and concerns regarding restoration impact on current habitat. They will also assist our regional scientists, as appropriate to collect survey data.

Next Steps

Phase 2 of this project will begin in September 2017 and end in March 2018. Tasks for this phase include further investigation of site hydrology, ditch restoration engineering, submitting permits for the project, as well as project coordination by Mass Audubon's Ecological Extension Service including reporting and preparation for Phase 3, which will be conducting the work on the ground. For Phase 4, an endowment will be set up to fund future management needs of the site.

Hydrology

Inter-Fluve will be contracted to collect additional field data in the summer and fall of 2017. They will investigate relative elevations within the Thicket to determine it the southwestern and central ditches can be combined and restored into one ditch or if the necessary grading would be too extensive and restoration should focus only on the central ditch. They will also determine if pipe infrastructure would need to be upgraded to handle the combined flow if the ditches are joined. At the end of their data analysis they will provide engineered designs ready to submission as part of a permit application and will flag out the proposed ditch location in the field.

Permitting

All land management will comply with current local, state, and federal rules and regulations, including

- Wetland Protection Code administered by the Nahant Conservation Commission;
- Wetlands Protection Act administered by the Massachusetts Department of Environmental Protection; and
- Federal Clean Water Act administered by the Environmental Protection Agency.

As all proposed work will involve work within a wetland or wetland buffer area, we will prepare a Notice of Intent for review by the Nahant Conservation Commission and Massachusetts Department of Environmental Protection Depending on the degree of grading needed for the restoration of the central ditch, Massachusetts Environmental Policy Act (MEPA) and Army Corps of Engineering (Corps 404) permits may also be required.

The permitting process will take a significant amount of time depending on the number of permits the town requires to complete all project components. Once a Notice of Intent is submitted, the town Conservation Commission typically conducts at least one site walk to discuss the project. We will be required to attend at least one Conservation Commission meeting to propose the project. If the commission has questions that require follow-up, the hearing can be continued to subsequent meetings. If the commission approves the project, they provide an Order of Conditions dictating stipulations on the work. This order is recorded in the Registry of Deeds, and after a comment period, we would be able to commence the work. It is critical to recognize that all components of this project are dependent on the permitting process and there are very few things we can do in the site until permits are approved.

We will design trails and the parking lot to meet standards for accessibility as laid out by the U.S. Forest Service standards for accessible trails. Parking and possibly bridges and boardwalks will need to meet standards of the Nahant building codes and other bylaws. We will meet with the local Building Inspector or other appropriate staff as necessary.

Coordination

Mass Audubon's Ecological Extension Service will continue the coordination of the project during Phase 2. Duties will include coordinating ditch restoration engineering with contracted hydrologist; maintaining an updated conversation between the town DPW, NE Mosquito, and Mass Audubon staff regarding the current infrastructure; preparing and submitting needed permits for the project; and preparing a final report on what was accomplished during phase 2 and providing an updated scope of work and finalized costs for phase 3. Table 7 provides a draft timeline and estimated costs for Phase 3.

Endowment

Mass Audubon has a goal of establishing for each sanctuary a stewardship endowment which generates sufficient income each year to cover the maintenance, visitor services and ecological management needs of the sanctuary. Such endowments provide for the long-term sustainability of the sanctuaries. Mass Audubon currently has more than 330 separate restricted endowment funds, most of which were established to support specific sanctuaries and programs. These endowment funds are pooled for investment purposes and overseen by the Investment Committee of the Board of Directors with the assistance of an investment consultant.

Table 7: *Subsequent phases of project with actions, cost and timeframe*

	Proposed Actions	Cost	Timeframe
Phase 2	Ditch Restoration Engineering	$35,636	Aug-Oct 2017
	Permitting	$15,000	October 2017-March 2018
	Coordinate short-term hydrology improvements and refine budget for Phase 3	$15,000	July 2017-March 2018
	Subtotal	$65,636	
Phase 3 (estimates)	Parking area	$30,000	March – November 2018
	Tree removal	$20,000	March – May 2018
	Wet Meadow restoration	$8,000	October – November 2018
	Install Boardwalk	$105,000	May 2018- May 2019
	Ditch Restoration	$200,000	November 2018- May 2019
	Ditch revegetation	$30,000	May- October 2019
	Invasive management	$20,000	August 2018- November 2021
	Coordinate Project and provide Final reports for 2018 and 2019	$30,000	March 2018- December 2019
	Subtotal	$443,000	
Phase 4	Establish maintenance endowment[1]	$530,000	

[1] At board-approved 4.25% spending rate would translate to $22,500/year.

Appendix A

Sample Pollinator Meadow Mix:

44.0% Schizachyrium scoparium (Andropogon scoparius), Fort Indiantown Gap-PA Ecotype (Little Bluestem, Fort Indiantown Gap-PA Ecotype)

18.0% Sorghstrum nutans, New England 2 Ecotype (Indiangrass, New England 2 Ecotype)

15.0% Elymus riparius, PA Ecotype (Riverbank Wildrye, PA Ecotype)

4.0% Tridens flavus (Purpletop)

3.5% Echinacea purpurea (Purple Coneflower)

3.0% Chamaecrista fasciculata (Cassia f.), PA Ecotype (Partridge Pea, PA Ecotype)

3.0% Rudbeckia hirta (Blackeyed Susan)

2.0% Penstemon digitalis, PA Ecotype (Tall White Beardtongue, PA Ecotype)

1.1% Lespedeza capitata, RI Ecotype (Roundhead Lespedeza, RI Ecotype)

1.0% Aster laevis (Symphyotrichum laeve), NY Ecotype (Smooth Blue Aster, NY Ecotype)

1.0% Aster novae-angliae (Symphyotrichum n.), PA Ecotype (New England Aster, PA Ecotype)

0.5% Baptisia australis, Southern WV Ecotype (Blue False Indigo, Southern WV Ecotype)

0.5% Senna hebecarpa (Cassia h.), VA & WV Ecotype (Wild Senna, VA & WV Ecotype)

0.5% Sisyrinchium angustifolium (Narrowleaf Blue Eyed Grass)

0.5% Tradescantia ohiensis, PA Ecotype (Ohio Spiderwort, PA Ecotype)

0.5% Zizia aurea, PA Ecotype (Golden Alexanders, PA Ecotype)

0.4% Aquilegia canadensis (Eastern Columbine)

0.4% Monarda fistulosa, Fort Indiantown Gap-PA Ecotype (Wild Bergamot, Fort Indiantown Gap-PA Ecotype)

0.2% Geum canadense, PA Ecotype (White Avens, PA Ecotype)

0.2% Solidago juncea, PA Ecotype (Early Goldenrod, PA Ecotype)

0.2% Solidago nemoralis, PA Ecotype (Gray Goldenrod, PA Ecotype)