CHANDLER POND MASTER PLAN

June 2024

kzla

PARKS AND RECREATION
CITY OF BOSTON

ACKNOWLEDGMENTS

Prepared for:

Mayor: Michelle Wu
Boston Parks Commissioner: Ryan Woods

The Boston Parks and Recreation Department creates and maintains clean, green, safe, and accessible open space in more than 2,300 acres of park land throughout Boston. The Department is responsible for 217 City parks, playgrounds and athletic fields, two golf courses, 65 squares, 17 fountains, 75 game courts, 16 historic and three active cemeteries, 30 urban wilds, four high school athletic fields, and approximately 125,000 trees, along with an additional 35,000 street trees.

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EXECUTIVE SUMMARY

This comprehensive Chandler Pond Master Plan encapsulates a multifaceted approach to rejuvenate and enhance a cherished community pond and its surrounding park ecosystem. Addressing a range of concerns from invasive species management and erosion mitigation to water quality improvement and climate resilience, this plan is poised to transform the landscape into a thriving, sustainable, and resilient urban oasis.

For decades, the park has been a destination for passive recreation and a respite from the city. While there are unique challenges such as extensive maintenance needs, steep topography, accessibility constraints, undesirable wildlife, excessive foot traffic, stormwater runoff and a variety of invasive species, there are opportunities for improvement that can achieve ecological restoration goals while also enhancing recreational and aesthetic features.

The primary objectives are to stabilize the shoreline, remove or limit invasive species, improve the ecological health/quality of buffer and woodland areas, evaluate and improve the pond's water quality, and create ways to enhance the visitor experience while being ecologically sensitive.

To achieve these objectives, the recommendations section of the master plan includes a comprehensive list of improvements which can be phased as funding and other resources allow. They include:

- The removal of invasive species that threaten the ecological balance of the park and the pond, improving biodiversity and restoring habitat using a science-driven approach that utilizes adaptive management.
- Mitigating erosion by identifying erosion-prone conditions and prioritizing susceptible areas. Nature-based solutions, such as vegetation stabilization will combat soil loss, prevent degradation, and enhance the resilience of the landscape against climate-induced challenges.
- Enhancing water quality by integrating vegetated buffer zones, native plantings, and supporting a comprehensive evaluation of water quality indicators.
- Improved access that provides an inclusive visitor experience and a system of designated access points that protect the delicate wetland and shoreline ecosystems.
- An emphasis on sustainable practices, including ongoing monitoring, adaptive management techniques, and routine maintenance. This ensures the sustained vibrancy and long-term health of the park.
- Forward-looking interventions that consider the rising temperatures, altered hydrology and extreme weather events expected as impacts of climate change. Resilient strategies, climate-responsive vegetation and continued assessment ensure long-term sustainability.

The master plan aligns with proven principles of pond and park management, guiding the park to improved water quality, stabilized shorelines, and a more balanced ecosystem. This vision anticipates challenges posed by climate change, ensuring a resilient, adaptable landscape that can withstand future uncertainties. The plan not only addresses immediate challenges, but also recognizes that the implementation schedule is uncertain. It lays out an overall implementation strategy that utilizes continued re-assessment of the existing conditions to best prioritize and phase future work. In addition to providing guidance on achievable and lasting improvements at Chandler Pond, this plan also offers essential best management practices and protocols that can be employed at similar pond-side locations within BPRD's property portfolio.

The restoration efforts described in the plan protect and improve the site's natural features while elevating the visitor experience, ensuring Chandler Pond will remain a community asset for future generations.

INTRODUCTION

PROCESS

The Chandler Pond Master Plan is the result of a collaborative effort between the Boston Parks & Recreation Department, the Friends of Chandler Pond, residents of Brighton and other stakeholders invested in the collective goal of improving the user experience at Chandler Pond and Gallagher Memorial Park.

In 2022, Kyle Zick Landscape Architecture, Inc. (KZLA) was selected to prepare the master plan and develop construction documents for the first phase of implementation of the master plan. The master plan includes recommendations for the entire Gallagher Memorial Park, with a special focus on Chandler Pond and its immediate shoreline. Recommendations focus on ecology, wetland resources, invasive vegetation, stormwater impacts, erosion, viewsheds, access, pedestrian circulation, and encroachments.

Several stakeholder presentations were conducted in the winter and spring of 2023, to review a summary of existing conditions and draft master plan strategies, as well as proposed Phase 1 implementation activities. Presentations were held at the January 2023 and February 2023 Friends of Chandler Pond Board meetings. Members' comments were a key component in developing the master plan and strategies for implementation.

A draft of the master plan and a preview of the first phase of implementation was presented at a separate public meeting held on March 16, 2023. An open comment period followed, with comments incorporated into the final master plan document and Phase 1 implementation plans.

This final report and recommendations plan is a culmination of an extensive study that summarizes the present site conditions and proposes a master plan and implementation strategy with design improvements guided by the feedback received through the engagement process.

BACKGROUND

Tucked away just a few blocks from Washington Street and Brighton Center, Gallagher Memorial Park and Chandler Pond are a popular amenity for area residents and students. Popular activities include birdwatching, picnicking, dog-walking and enjoyment of the natural scenic features.

Purpose and Scope

This master planning effort was initiated by the Friends of Chandler Pond, a non-profit organization working to restore, maintain, and preserve the character and historic quality of Chandler Pond and its shoreline. Originally founded in 1996 as the Chandler Pond Preservation Society, the name was changed in 2019 to the Friends of Chandler Pond. Funding for the master plan and initial construction phase was solicited by the Friends of Chandler Pond and managed by the Boston Parks and Recreation Department.

The purpose of the master plan is to recommend best practices for restoring and protecting the ecological health of Chandler Pond and the adjacent park. The plan covers the shoreline and upland zones of the Boston Parks property, with limited recommendations for outreach and maintenance improvements for areas outside of the property boundary. Recognizing the importance of ongoing maintenance in any ecological restoration project, the master plan also includes guidance on management and maintenance for short and long-term projects. In addition, the master plan includes ways that volunteer support can be used to supplement or maintain specific projects.

History

Chandler Pond is 10.8 acre man-made pond in Alice Gallagher Memorial Park, located in the Brighton neighborhood of Boston, Massachusetts. Locally, the park and Pond are collectively referred to as Chandler Pond Park. Currently owned by the City of Boston, the pond itself was originally excavated in 1855 to provide a supply of ice for residential and commercial customers before modern

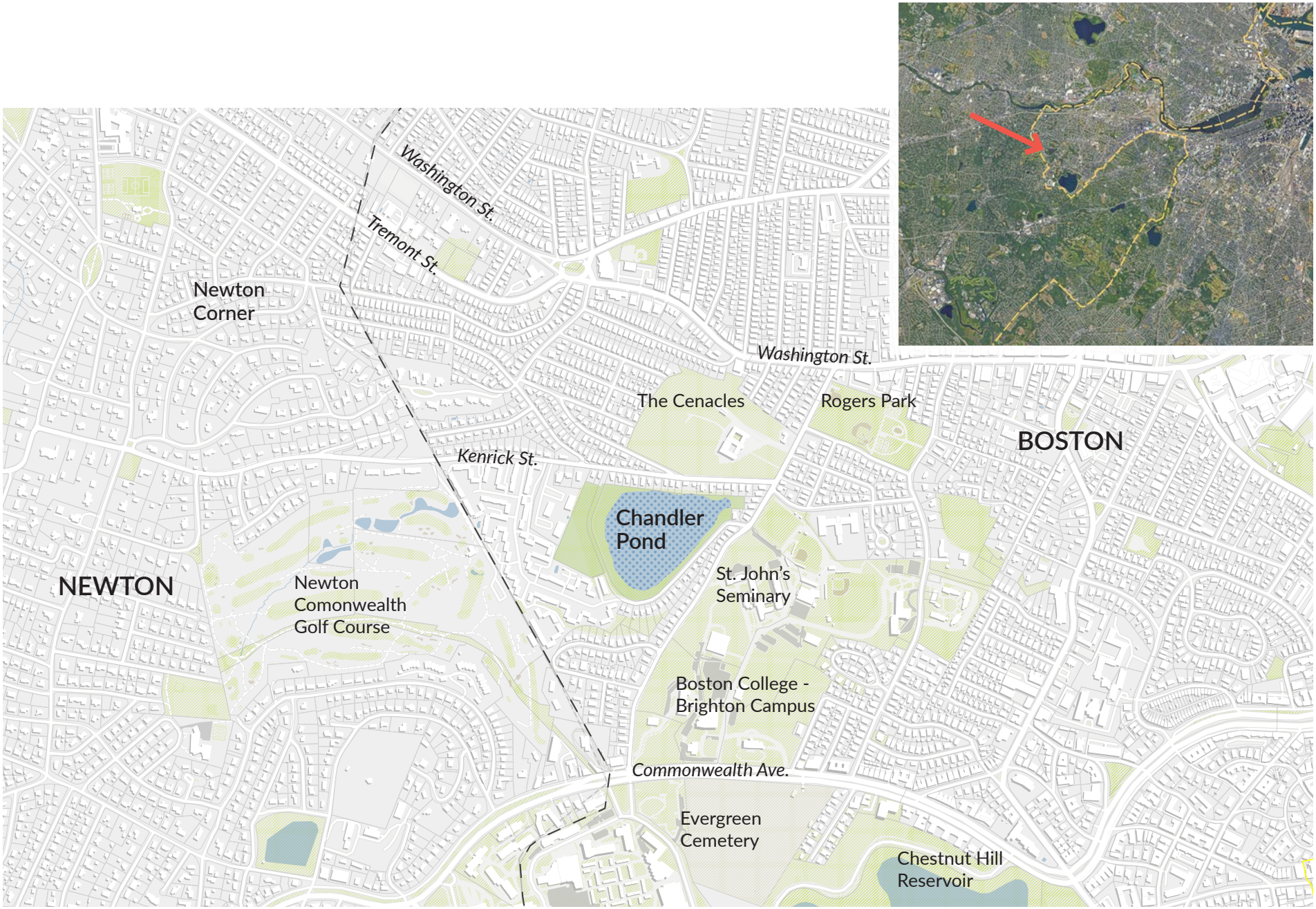


FIGURE 1.1 VICINITY MAP

Esri Community Maps Contributors, Boston College Campus GIS, City of Boston, City of Newton, MassGIS, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

refrigeration. It was part of a network of 20 similar ponds throughout Allston-Brighton, of which only Chandler remains.

The original developer, William C. Strong, sold the pond to Malcolm Chandler, an established local ice merchant. Once refrigeration was introduced, the land switched hands a number of times before ultimately being subdivided into residential lots. The City of Boston acquired the pond acreage in the 1930s, and in 1941, the city established the Alice Gallagher Memorial Park on the southwestern rim of the pond. Alice Gallagher, the wife of Boston City Councilor Edward Gallagher, was active in charitable work in the Allston-Brighton area.

Recent Activity

In the last several decades, the pond has received treatment for invasive aquatic plant species (Eurasian Milfoil), and there has been spot treatment for nuisance species around the pond and parkland. In addition, volunteer efforts, coordinated by the Friends of Chandler Pond, regularly hand-harvest invasive species.

In 1999 and 2000, there was a dredging and restoration project at the pond in response to concerns about the decreased water depth. The dredging effort was supplemented by a shoreline stabilization demonstration project. In total, the project removed 27,000 cubic yards of sediment, planted 2,750 native wetland plants, and installed 300 linear feet of erosion control materials. The goal of the pilot project was to establish emergent vegetation along the shoreline to stabilize the eroding bank, and to sequester phosphorus and other pollutants while improving aquatic wildlife habitat. While other options were considered, such as daylighting a portion of Dana Brook or adding wetlands at the stormwater inlets, the perimeter planting was determined to be the most cost-effective short-term solution. However, the shoreline stabilization and planting work was limited in scope, maintenance was inadequate, and no additional planting efforts were completed.

In 2020, a vegetation management plan was solicited by the Friends of Chandler Pond and completed by Crawford Land Management, but not implemented.

FIGURE 1.2 VIEW ACROSS THE POND, 1890
Photo Courtesy of the Boston Public Library

EXISTING CONDITIONS

SITE ANALYSIS AND ASSESSMENT

Process and Methods

To understand how best to improve ecological conditions at the pond, the existing conditions were cataloged and evaluated. These evaluations included examinations of the pond's shoreline, its vegetative buffer, the extent of wetlands on the property, official and unsanctioned circulation routes, vegetation composition and quality, existing access points, areas of erosion, and slopes.

These assessments were completed through a combination of desktop analysis and field observations.

During September 2022, LEC Environmental Consultants, Inc. conducted a wetland delineation for the pond, placing flags at the perimeter of the wetland around the pond. The boundary determination was based on criteria enumerated in the Massachusetts Wetlands Protection Act (M.G.L. c. 131, s. 40) and implementing regulations at 310 CMR 10.00, the City of Boston Wetlands Protection Ordinance and the Federal Clean Water Act (33 U.S.C. 1344, s.404). Hydric soils and plant community composition were evaluated in accordance with the handbook *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* (March 1995) and the *Field Indicators for Identifying Hydric Soils in New England* (Version 4, June 2019). LEC also gathered data regarding floristic, topographic, edaphic, and surficial hydrologic site characteristics.

During the summer and fall of 2022, a survey was conducted for the property by Feldman Engineering. The survey recorded the flagged wetland locations and included property boundaries as well as the locations of utilities, pathways, stand-alone vegetation, and features such as fences and benches. The survey also included topography, showing the elevations of the site and the contours indicating the slopes.

A vegetation management plan completed by Crawford Land Management in 2020 was provided to the project team. That assessment provided the basis for the evaluation of native and invasive species on the site, which was field-verified, and amended by KZLA.

Further field reconnaissance was used to evaluate viewsheds and access points, assess the severity of erosion, and to locate social trails along Chandler Pond's shoreline. Desktop analysis was used to evaluate slopes and estimate the extent of the sewershed and watershed of the entire park site. The analysis results are presented with maps and descriptions on the following pages.

How This Information Is Used

Evaluating existing conditions provides a baseline from which recommendations can be made for improvement. It also provides documentation of the current situation, which can be compared to progress that is made as portions of the master plan are implemented.

KEY CONCEPTS

Features of a Healthy Pond

Healthy ponds have a diverse collection of native plants in and around the pond. Native plants support native birds, mammals, fish, invertebrates, and insects, helping to create a balanced ecosystem. This type of biodiversity creates a resilient system in the face of changes such as disease, storms, and the effects of climate change.

Healthy ponds also have a **vegetated buffer** - an area around the perimeter of the pond that is made up of groundcover plants, shrubs and trees, not just turf. These plants help to hold the soil in place and filter pollutants that would otherwise run into the pond. The buffer also provides habitat for wildlife. Effective buffers can even reduce or delay the need for costly engineering solutions such as dredging. While thicker buffers are better, even a buffer of 10' between the pond edge and the upland area can provide benefits, if it is healthy and robust[1].

Succession

Ponds, whether natural or man-made, progress over time from open water to wetlands to fields to forests. This process is called succession. How quickly this transformation occurs depends on the level of maintenance the pond receives, and how fast it fills in with sediment and organic matter, like leaves, fallen branches, and For urban ponds, such as Chandler Pond, succession is accelerated by what is carried into the pond through the storm drain system, and by the erosion of its shoreline.

Pond Zones

Ponds and their shorelines can be divided into zones, described by their differences in physical characteristics, such as topography, soil type, and vegetation. The zones are interconnected, but have unique characteristics.

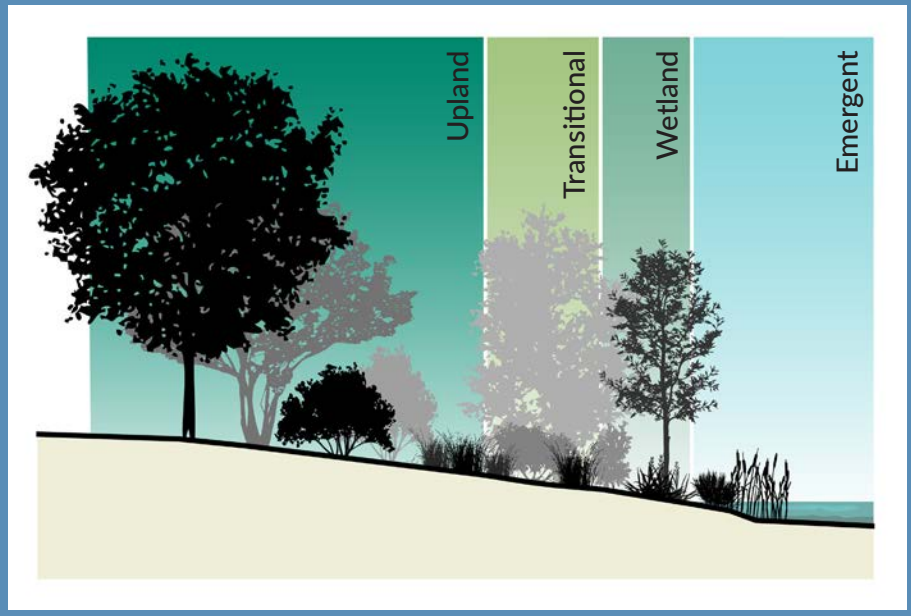
1 Hawes, E. and Smith, M. (2005). Riparian Buffer Zones: Functions and Recommended Widths. Prepared for the Eightmile River Wild and Scenic Study Committee. https://www.hebronnh.gov/sites/g/files/vyhlif3256/f/uploads/riparian_buffer_science_yale.pdf

The Emergent Zone is where you will find plants that have their roots submerged in the water, but the upper portion of the plant 'emerges' from the water. Plants in this zone take up nutrients from the pond and can help keep algae under control.

Wetlands are the link between the land and the water. In large storms, healthy wetlands absorb and slow water, helping to take up excess nutrients, sediment, and other pollutants.

The highest section of the slope is the Upland Zone, where plants that can tolerate drier conditions grow. Often deep-rooted, plants in this zone help hold soils in place and increase soil infiltration capacity.

Between the Upland Zone and the Wetland is an area called the Transitional Zone, which can experience fluctuations in water availability. Plants well-adapted to this zone tend to tolerate both wet and dry soils, and both semi-shade and sunny conditions. They contribute to the diversity, structure, and function of both wetland and upland ecosystems.



Urban Pond Stressors

Urban ponds can face various stressors due to the surrounding human activities and environmental factors. These include:

Stormwater Runoff and Pollutants

In urban landscapes, stormwater runoff is generated by rain and snowmelt that flows over impermeable surfaces like roads, roofs, and compacted soils, without soaking into the ground. This runoff typically ends up flowing into a storm drain or a water body.

Stormwater runoff pick ups up trash, chemicals, oil, and sediment from construction sites, over-fertilized lawns and golf courses, bare soil, animal waste, and illegal dumping sites along the way. These pollution sources can result in ponds that suffer from increases in sedimentation, heavy metals, road salt, bacteria, and nutrients like phosphorus and nitrogen, reducing the water quality of the pond.

Erosion

In this context, erosion refers to the wearing away or removal of soil from the land surrounding the pond through natural forces, such as water flow and wind, as well as human activities. Erosion can cause a loss of habitat, harming wildlife that depend on the areas for food, shelter, or protection. As the pond bank becomes less stable, it increases the risk of further erosion.

When eroded soil enters the pond, it is called sedimentation. The eroded soil may contain pollutants, such as fertilizers and pesticides, causing water quality issues and harming aquatic life. Sedimentation also reduces the water depth and smothers aquatic habitats, disrupting the pond's ecosystem.

Vegetation plays a crucial role in stabilizing the soil along the pond's banks. Plants, such as grasses, shrubs, and trees, help to bind the soil together with their root systems, reducing the impact of water flow. Where vegetation is removed, or the vegetation has shallow roots, there is an increased vulnerability to erosion.

Habitat Fragmentation

Through urbanization, continuous areas of natural habitat are often divided into smaller, isolated patches. Small patches may not be large enough to sustain viable populations of certain plant and animal species, reducing biodiversity. Physical barriers, such as roads and buildings, block wildlife movement and disrupt migration and dispersal patterns. Smaller and isolated habitats are also more vulnerable to natural disasters, disease outbreaks, and climate change impacts.

While Chandler Pond used to be part of a network of ponds, it no longer has a direct connection to neighboring natural habitats, reducing its resiliency.

Invasive species

Urban areas are often susceptible to invasive species because of fragmented habitats with increased exposure to disturbances and the limited resources available to stop their spread. Invasive plant and animal species outcompete native species, disrupting the ecosystem balance, and altering a pond's ecology.

Artificial Hydrology

Changes in local land use and stormwater drainage systems alter the flow patterns, temperature, and water levels in urban ponds beyond the variability that would be expected in a natural system.

Climate Change

By definition, ponds are shallow water bodies, and are easily impacted by changes in temperature, precipitation patterns, and extreme weather events, which can disrupt the pond's ecological balance and affect the survival of various species.

Trash and Litter

Urban ponds can accumulate litter and debris through visitors and stormwater runoff, causing aesthetic issues and posing a threat of entanglement and ingestion to terrestrial animals and aquatic life.

EXISTING LAND USE

At approximately 11 acres, Chandler Pond makes up 60% of the property. The remaining 40% is divided into lawn, paved paths, wooded area, and shoreline buffer.

Notably, the property has a relatively high percentage of lawn area given that the park is not dedicated to active recreation, such as athletic fields. The large expanse of lawn is attractive to Canada geese, which create water quality problems and destroy grassy vegetation. Almost all other wildlife suffers from regular mowing at the pond edge.

A small percentage of the land within the park is paved path. This small percentage helps limit the amount of impervious surface within the park boundary that contributes runoff to the pond. However, it also means that individuals with mobility impairments have no access to the pond edge.

The wooded area makes up about a third of the total land area of the property. As an urban woodland, it has a number of challenges including dumping of trash, encroachment by neighboring property owners, salt runoff from the adjacent parking areas, and the unchecked growth of invasive species.

Shoreline buffer makes up the remainder of the property. The pond has a limited buffer area along most of its shoreline, particularly along Lake Shore Road where the vegetative buffer is often less than 10'. At times, turf extends right to the water's edge. This very thin vegetated buffer does not provide much benefit as habitat for wildlife, does not hold soil in place very well, and is not particularly effective at slowing and infiltrating stormwater runoff that contains excess nutrients and other pollutants. There is generally very little aquatic vegetation in the pond's emergent zone, which would help to actively remove pollutants from the water.

The mowed turf areas along the shoreline and on the adjacent slopes are moderately to severely compacted. Compacted soils cannot infiltrate water well, and combined with steep slopes and shallow turf roots, the mowed lawn cannot resist the erosive forces of rainfall.

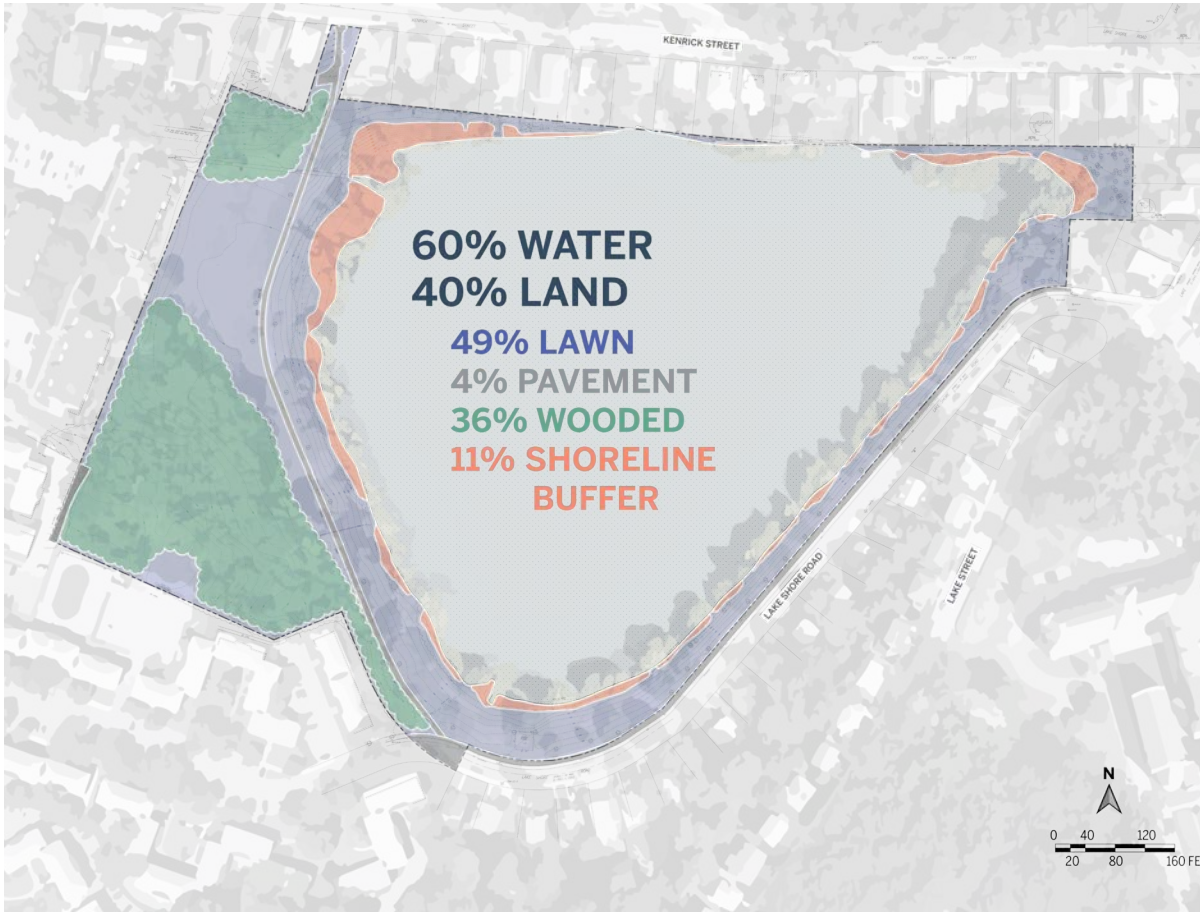


FIGURE 2.1 LAND USE PERCENTAGES AT GALLAGHER MEMORIAL PARK

FIGURE 2.2 (TOP) EXAMPLE OF WOODED AREA
Wooded area is a mix of native species and invasives.

FIGURE 2.3 (BOTTOM) EXAMPLE OF LAWN IN PARK
Lawn is maintenance-heavy, attracts Canada geese, and adds little ecological value

FIGURE 2.4 (TOP) EXAMPLE OF SHORELINE BUFFER
Existing buffer area contains some native vegetation, as well as invasives, and areas of lawn.

FIGURE 2.5 (BOTTOM) EXAMPLE OF SIDEWALK ALONG LAKE SHORE ROAD
The existing concrete sidewalk along Lake Shore Road is in good condition, but provides no direct pond access.

FIGURE 2.6 (TOP) EXAMPLE OF SHORELINE BUFFER
Existing buffer area contains some native vegetation, as well as invasives, and areas of lawn.

FIGURE 2.7 (BOTTOM) EXAMPLE OF INTERNAL PATHWAY
Bituminous concrete paved walkway internal to the park connects Lake Shore Road and Kenrick Street.

WATER FEATURES AND DRAINAGE PATHWAYS

Chandler Pond has four inlet pipes that drain into the pond. A single outlet at the northeast corner of the pond serves as the only water control feature. The outlet structure is fitted with a trash rack. Vegetation debris and other trash regularly collects at the outlet structure.

Inlets A and C are large diameter (30”-36”) concrete pipes. Inlet B is a 12” diameter pipe that comes from an area drain in the woodland area. It may be connected to an upstream drainage system but this information was not readily available. Inlet D is a direct connection to the pond from a pair of storm drains on Lake Shore Road. There are no pre-treatment mechanisms visible on any of the accessible catch basins or areas drains.

A

B

C

D

FIGURE 2.8 WATER FEATURES AND DRAINAGE AT CHANDLER POND

A,B, C, and D designate the four pipes that bring stormwater into Chandler Pond from the surrounding neighborhood. A single outlet structure on the northeast corner of the park is the only water control feature

Watershed and Sewershed

The pond's watershed is the land area that drains directly to the pond over the surface of the ground. The pond's sewershed is the area of land that drains to the pond by flowing in pipes to single points, like the pond's inlet pipes. Within the master plan, 'watershed' is used when discussing surface flow and 'sewershed' is used when referring to stormwater that travels into the pond through underground pipes.

Chandler Pond's location in a highly urbanized area, and its history as a man-made pond, mean that the watershed of the pond itself is relatively small. While the park area and some surrounding properties drain directly into the pond, most of the water reaching the pond comes from the storm drain system. The water is channeled into the pond through the catch basins in the surrounding roadways and through the channelization of Dana Brook, which originates in the City of Newton to the west.

Originally, water leaving the pond flowed to the Charles River via Faneuil Brook. Due to development, Faneuil Brook is now 100% contained in an underground culvert. Overflow water from Chandler Pond now travels in about 6000 feet of underground pipes eventually emptying into the lower Charles River. The storm drain system is controlled by the Boston Water and Sewer Commission.

FIGURE 2.9 CATCH BASINS ON LAKE SHORE ROAD
This pair of catch basins drains water from Lake Shore Road directly into Chandler Pond.

FIGURE 2.10 AREA DRAIN IN THE WOODLAND AREA
This area drain connects to inlet pipe B, draining into the pond.

FIGURE 2.11 OUTLET STRUCTURE
The pond's single outlet structure is located at the northeast corner of the pond.

FIGURE 2.12 TRASH RACK AT OUTLET STRUCTURE
A trash rack strains out large debris from entering the outlet pipe. Debris clean-up is largely done by volunteers. .

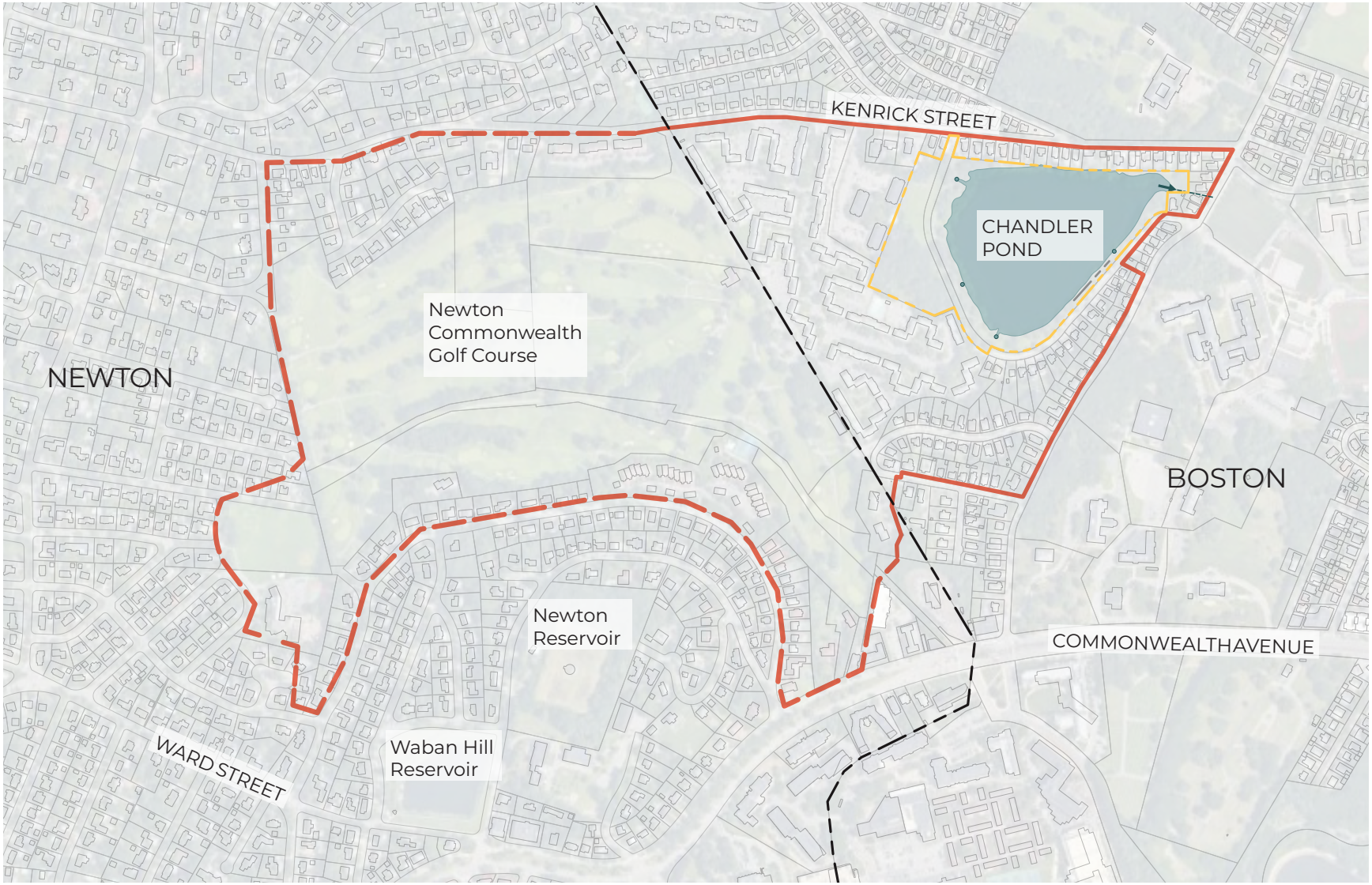


FIGURE 2.13 APPROXIMATE SEWERSHED OF CHANDLER POND

The sewershed of Chandler Pond was determined using maps provided by the Boston Water and Sewer Commission for the portion of the system contained within Boston city limits as well as a desktop analysis of slopes and likely storm drain connections within Newton, MA.

CIRCULATION AND ACCESS POINTS

The primary circulation route around the pond includes the sidewalk along Lake Shore Road and a 8'+ wide asphalt path that runs through the Park from Lake Shore Road to Kenrick Street. The paved circulation path serves as the main pathway for visitors, maintenance vehicles, and emergency personnel. Presently, there are no defined pathways into the wooded area of the property.

In addition to the main paved path, there are numerous social trails - places where people make their own paths through the vegetation, often made visible by a worn path through the lawn or trampled undergrowth. In general, social trails around the pond have developed where people are trying to be close to the water, enjoy a good view or find some privacy. In addition, visitors are creating their own access points to reach the water's edge.

In many cases, the social paths and access points nearest the shoreline are resulting in erosion of the shoreline and degradation of the existing shoreline vegetated buffer.

FIGURE 2.14 (LEFT COLUMN) OFFICIAL PATHWAYS
Main circulation path along Lake Shore Road (a), intersection with bituminous in-park path (b), and entrance at Kenrick St. (c) with gates that limit maintenance vehicle access

FIGURE 2.15 (RIGHT COLUMN) SOCIAL TRAILS AND UNSANCTIONED ACCESS POINTS
Evidence of social trails and unsanctioned access points resulting in erosion and damage to vegetation, shown near Lake Shore Rd and Lake Street (d), the pond edge near Inlet C (e), and near Inlet A (f) .

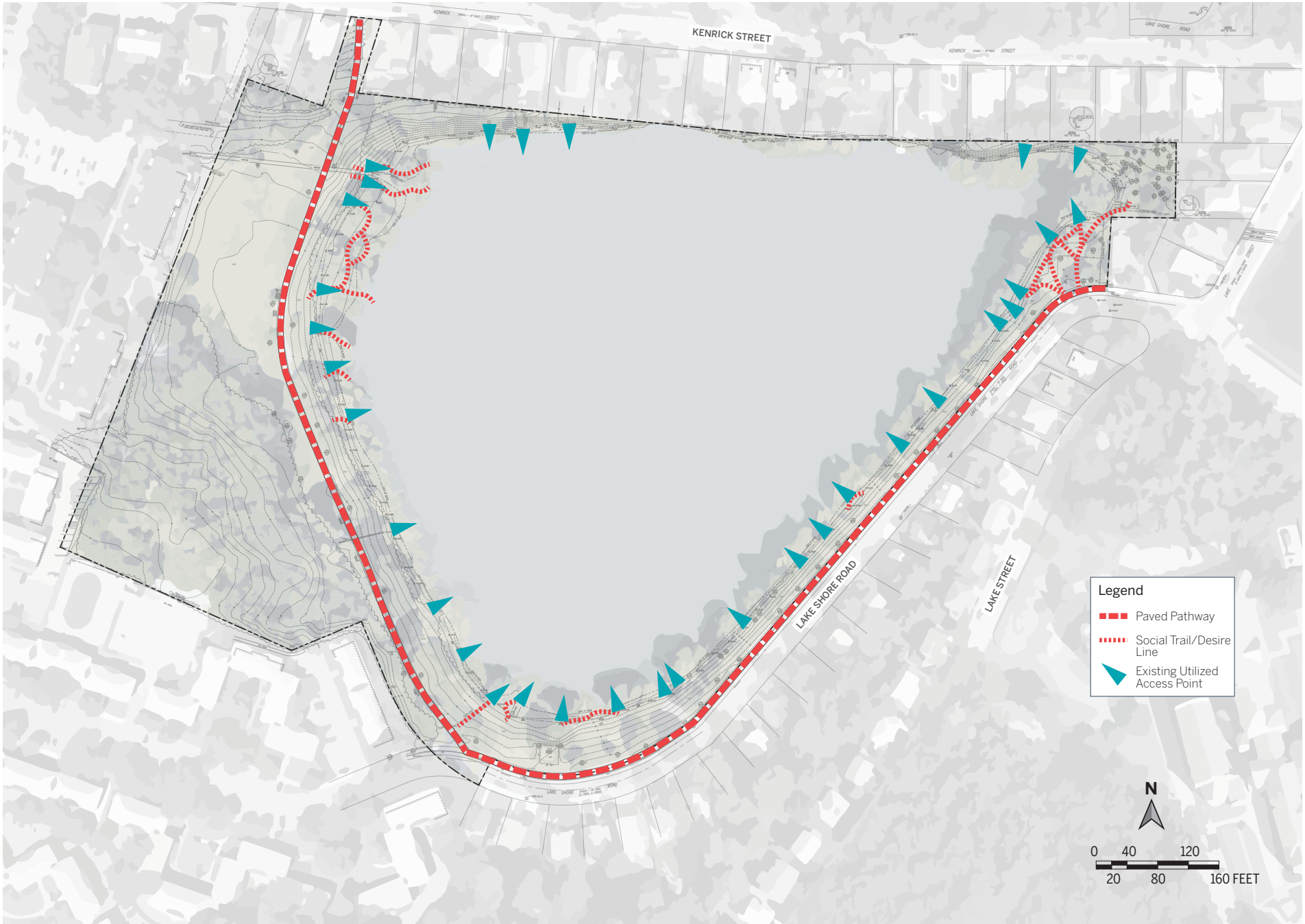


FIGURE 2.16 CIRCULATION AND ACCESS POINTS AT CHANDLER POND

Locations of official paved pathways at Gallagher Memorial Park, along with the locations identified through field visits as unsanctioned social trails/desire lines and access points.

EROSION

Erosion is the removal of soil from one location to another by natural forces like wind or water. At Chandler Pond, erosion results in sediment entering the pond, reducing the water level, smothering aquatic vegetation and diminishing the pond's capacity to hold water. This accelerates the need for dredging. Soil particles also hold onto some types of pollutants, so when the soil enters the pond, it brings the pollutants with it.

Some erosion around the pond occurs because the slope of the land adjacent to the pond is steep, making it difficult to establish vegetation. In addition, water moves quickly over steep slopes if it isn't slowed down. In many cases, human impacts, such as the wear from social trails or foot traffic at access points are increasing the number of locations experiencing erosion or accelerating the rate of erosion. Disturbed soil can create unstable banks, leading to even more erosion. So, while erosion is a natural process, human activities can exacerbate the problem.

In addition to causing sedimentation and pollution, erosion leads to colonization by invasive species. Invasive species are often the first vegetation to start growing on bare ground because of their high seed counts and tolerance for a wide range of environments. They can out-compete native vegetation in those situations.

FIGURE 2.17 (AT RIGHT) EXAMPLES OF EROSION AT CHANDLER POND

FIGURE 2.18 EROSION HOTSPOTS AT CHANDLER POND

Areas with high levels of erosion were identified through field visits. While some level of erosion can be attributed to steep slopes, much of the erosion evident at the site stems from compacted soil, foot traffic, and a lack of deep-rooted vegetation.

TREE COMPOSITION

Trees make up the overhead structure of the park. Their size and long life spans mean they can have an oversized impact on the health and quality of the park's vegetation.

For analysis, the trees were divided into three large categories - native, non-native, and invasive.

Native trees are those that are native to New England, according to the United States Department of Agriculture (USDA) Plant List of Attributes, Names, Taxonomy, and Symbols (PLANTS) database, available at: https://plants.usda.gov/home.

Non-native trees are those that are not native to New England, but which have become common through their use, and have been researched and proven to be non-aggressive in terms of expanding into natural areas or minimally managed habitats. Their presence is not known to cause environmental or economic harm, though they may not provide as many ecological benefits as a native species does. However, trees native to warmer parts of the country should be considered given the increasing temperatures expected with climate change.

For the purposes of the master plan, invasive trees are those on the Massachusetts Prohibited Plant List, a list of invasive plants banned from import, sale, or trade in Massachusetts. The full list is available here, and updated periodically: https://www.mass.gov/massachusetts-prohibited-plant-list.

The ban includes all cultivars, varieties and hybrids of the species listed. The plants were identified by the Massachusetts Invasive Plant Advisory Group (MIPAG). More information is available at: https://www.massnrc.org/mipag/

MIPAG defines invasive plants as "non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems."

The map in Figure 2.19 highlights the pockets of invasive tree species at the Park. Individual trees were not cataloged in the woodland areas, but more information on their composition is covered in the next section.

Even native trees can be somewhat aggressive. For example, Black Willow trees make up a substantial portion of the trees along the shoreline. While their aggressive growth can be beneficial for stabilizing banks, providing wildlife habitat, and preventing erosion, it can also be a concern in some situations. Since willows can readily root from broken or fallen branches, they will often be found in large tangles, obscuring views. The ease with which they take root also means that they are responsible for some of the shoreline creep that is evident at the pond - where vegetation takes over the shallower areas of the pond, trapping silt and organic matter, leading to a decrease in the pond's surface area.

More information on invasive trees and techniques for their removal can be found in the Appendix.

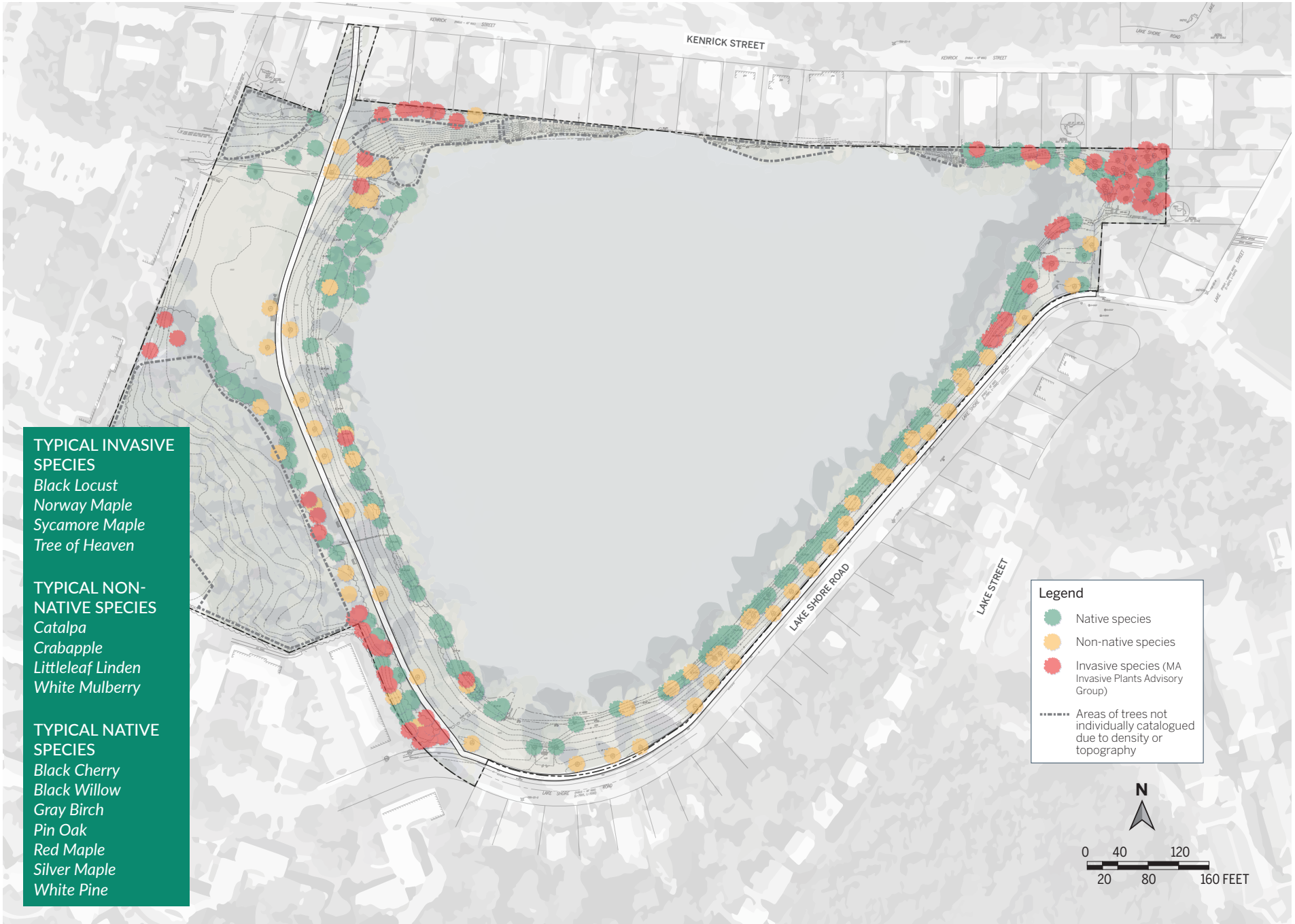


FIGURE 2.19 CLASSIFICATION OF TREES AT CHANDLER POND
Classification of trees at Chandler Pond into Native, Non-Native, and Invasive.

INVASIVE VEGETATION

This section focuses on invasive shrubs, perennials, and the larger expanses of woodland area where individual trees were not surveyed.

At least 13 invasive species were cataloged at the pond and park in the summer and fall of 2022. Aquatic invasive species were not included in the assessment, although members of the Friends of Chandler Pond have identified Eurasian milfoil and European naiad. See the Appendix for more information on managing the terrestrial invasive vegetation species found at the park.

Effect of Invasive Species

Invasive species can enter a new area through human activities, both intentional (e.g. landscaping) or accidental (e.g. soil transport for construction, seeds hitchhiking on clothing, shoes or equipment). Invasive plants can also be spread in waterways. Birds, mammals and other wildlife also eat fruits or seeds of invasive plants and disperse them to new locations, or carry bits of vegetation with them that sprout roots where they land.

Whether they were introduced by people or brought in by wildlife, terrestrial invasive plant species have a number of ways in which they out-compete native species and degrade the ecosystems in which they get established.

Rapid Growth or Reproduction

Invasive plants often have fast growth rates and can spread quickly by producing numerous seeds, reproducing from stems, roots or rhizomes, or having efficient methods of dispersal through wind, water, or animal vectors.

Extended Seed Viability and Tolerance for Disturbance

Invasive plants often produce seeds that remain viable for long periods of time. They may wait out unfavorable conditions for years, and germinate when conditions are better or when soil disturbance brings them to the surface. Many invasive plants are well-suited to colonizing disturbed areas such as roadsides, construction sites, or areas affected by natural disasters.

Adaptability and Tolerance

Invasive plants are typically highly adaptable to a wide range of environmental conditions, allowing them to thrive in various habitats and out-compete native species that may be specialized and less versatile. They may out-compete native species for resources like water, nutrients, and sunlight.

Reduce Light Availability

Some invasive species leaf out very early in the spring. While this puts them at risk for late season frosts, it also means that they can shade out native species that might germinate or leaf out later in the season. Other invasives develop very dense canopies, putting their energy into producing large leaves. The invasive plant's dense canopy blocks sunlight from reaching the ground.

KEY

INVASIVE TREE SEEDLINGS AND SAPLINGS

- T1 *Black Locust*
- T2 *Norway Maple*
- T3 *Sycamore Maple*
- T4 *Tree of Heaven*

INVASIVE SHRUBS AND HERBACEOUS VEGETATION

- SH1 *Autumn Olive*
- SH2 *Buckthorn, Common & Glossy*
- SH3 *Garlic Mustard*
- SH4 *Honeysuckles*
- SH5 *Knotweed*
- SH6 *Multiflora Rose*
- SH7 *Oriental Bittersweet*
- SH8 *Purple Loosestrife*

NUISANCE VEGETATION

- N1 *Bittersweet Nightshade*
- N2 *Black Willow Overgrowth*
- N3 *Burdock*
- N4 *Cattails*
- N5 *English Ivy*
- N6 *Lily of the Valley*
- N7 *Poison Ivy*
- N8 *Privet*
- N9 *White mulberry*

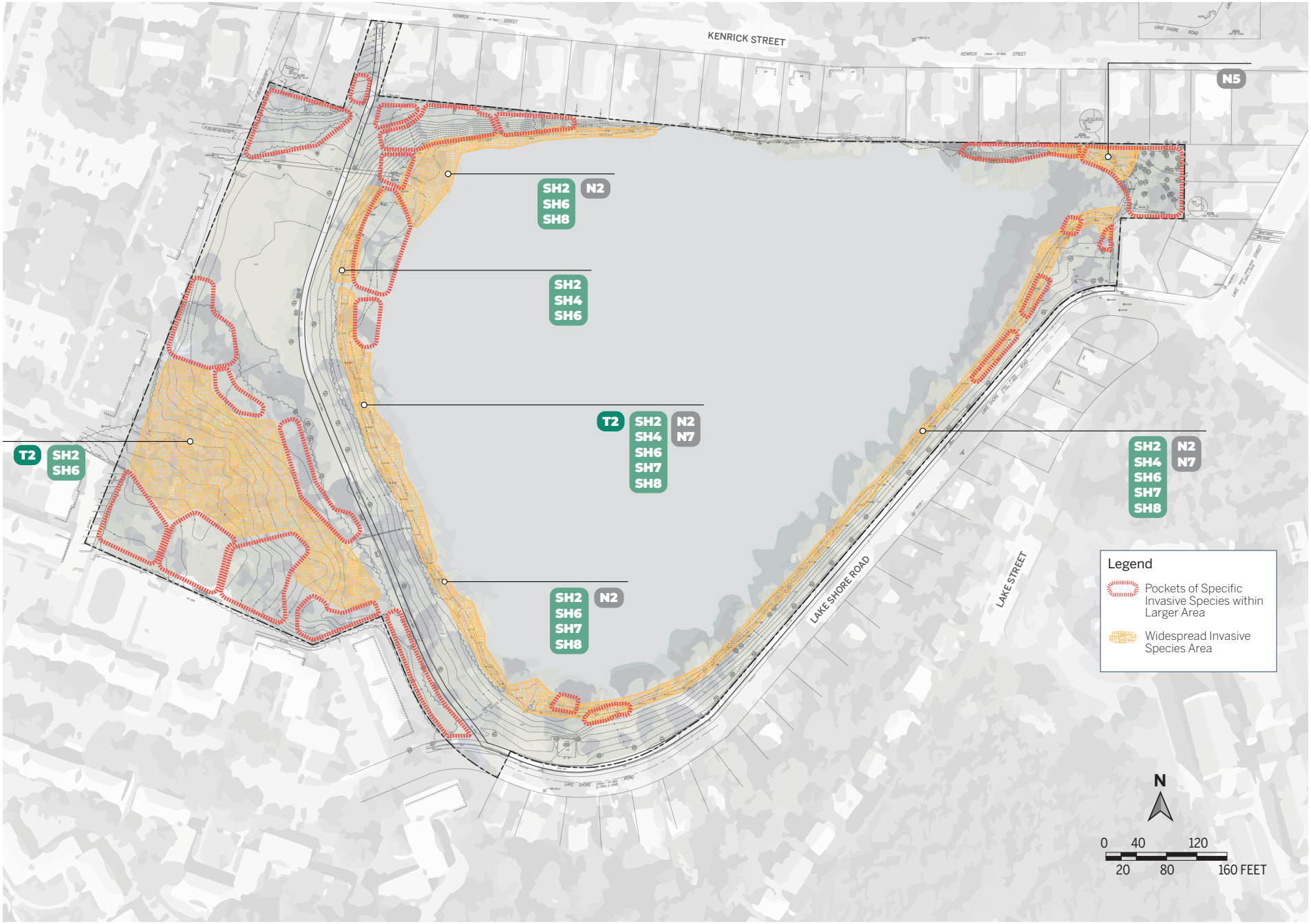


FIGURE 2.20 SUMMARY OF WIDESPREAD AREAS OF INVASIVE SPECIES AT CHANDLER POND

*Invasive vegetation at Chandler Pond, including tree saplings and seedlings, shrubs, and herbaceous vegetation. Key at left. Submergent aquatic vegetation** that may also be present include Eurasian milfoil (Myriophyllum spicatum) and European naiad (Najas minor). **Species identification provided by Bill King of the Friends of Chandler Pond.*

In both cases, the light available for native plants to grow and reproduce is reduced. Without native plant seedlings, the native plant population drops. This can also impact native wildlife such as insects and birds that are adapted to specific light levels.

Climbing and Vining

Some invasive plants have climbing or vining growth habits, using specific adaptations that enable them to use neighboring plants, trees, or structures for support as they grow upward. Once the climbing invasive plants have established a foothold on native plants, they can rapidly spread and cover them, reducing the native plant's access to sunlight, nutrients, and space. The covered native plants may struggle to survive and eventually become shaded out or die off. In addition, a mature woody vine can put a significant amount of weight on a tree, breaking branches or causing the tree to topple over.

Allelopathy

Some invasive plants release chemicals into the soil that inhibit the growth of nearby plants, giving them a competitive advantage and preventing the establishment of native species.

KEY

INVASIVE TREE SEEDLINGS AND SAPLINGS

- T1 *Black Locust*
- T2 *Norway Maple*
- T3 *Sycamore Maple*
- T4 *Tree of Heaven*

INVASIVE SHRUBS AND HERBACEOUS VEGETATION

- SH1 *Autumn Olive*
- SH2 *Buckthorn, Common & Glossy*
- SH3 *Garlic Mustard*
- SH4 *Honeysuckles*
- SH5 *Knotweed*
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- SH7 *Oriental Bittersweet*
- SH8 *Purple Loosestrife*

NUISANCE VEGETATION

- N1 *Bittersweet Nightshade*
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- N7 *Poison Ivy*
- N8 *Privet*
- N9 *White mulberry*

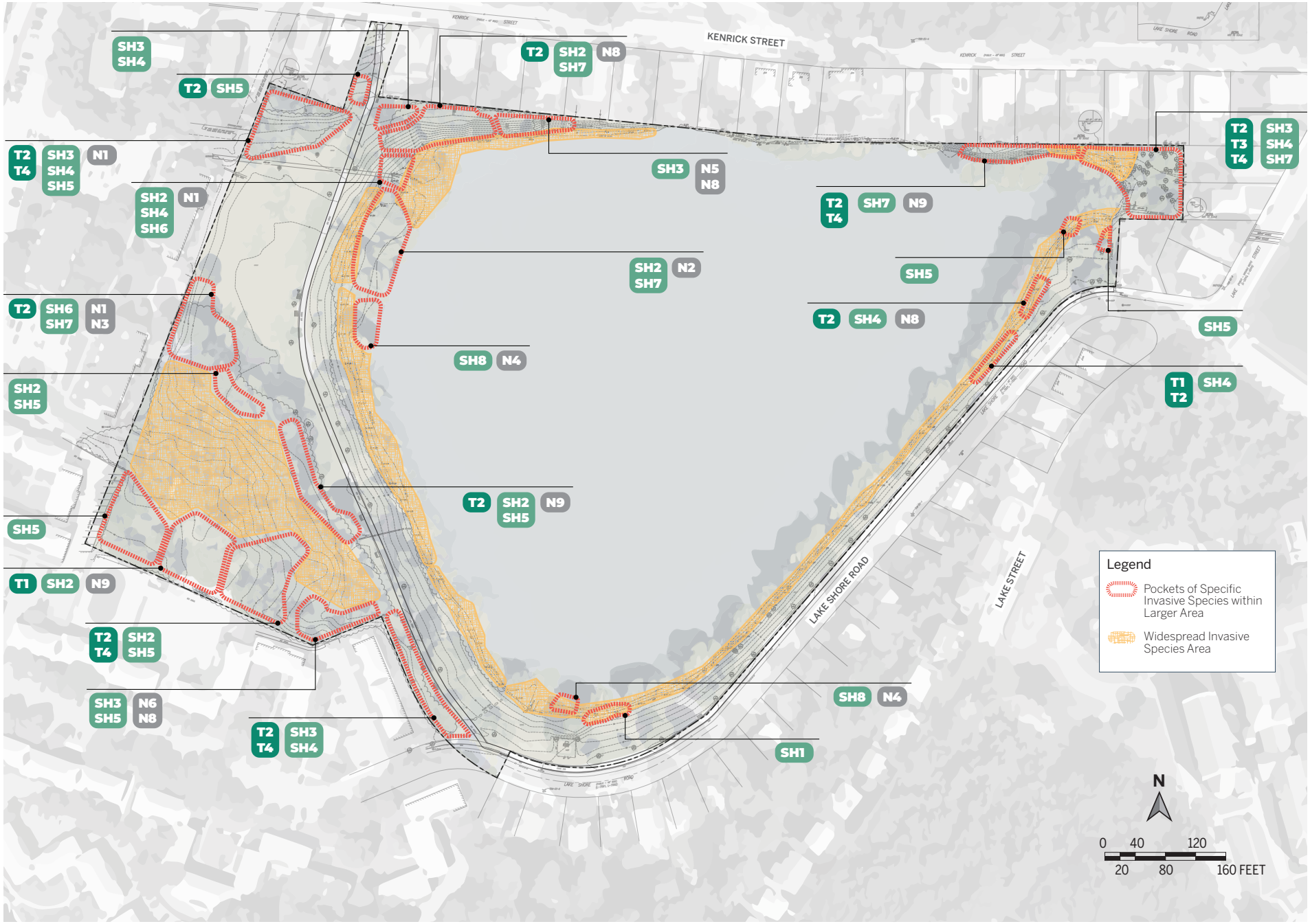

FIGURE 2.21 SUMMARY OF ISOLATED COLONIES OF INVASIVE SPECIES AT CHANDLER POND

Invasive vegetation at Chandler Pond, including tree saplings and seedlings, shrubs, and herbaceous vegetation. Key at left.

SLOPES

Slope refers to how much change there is in elevation for a given distance. Higher slope percentages designate a steeper area. Outdoors, slopes under 2% are hard to distinguish from completely flat areas. Slopes less than 5% are generally considered comfortable to walk along without too much effort. When slopes are greater than 5%, it can be difficult to maintain safe footing and rainfall is more likely to run over the surface rather than infiltrate into the ground.

Slopes at the park and around the shoreline of Chandler Pond range from less than 2% on some of the open lawn areas and paved walkways to greater than 50% on the steepest slopes surrounding the pond. While slopes up to 33% can be mowed, the limit depends on the mowing equipment being used.

The steepest areas are generally on the edge of the pond itself, and where the park abuts neighboring residential properties along Kenrick Street. Steep slopes are vulnerable to erosion, are difficult places to get vegetation established, and present challenges to access for maintenance and monitoring.

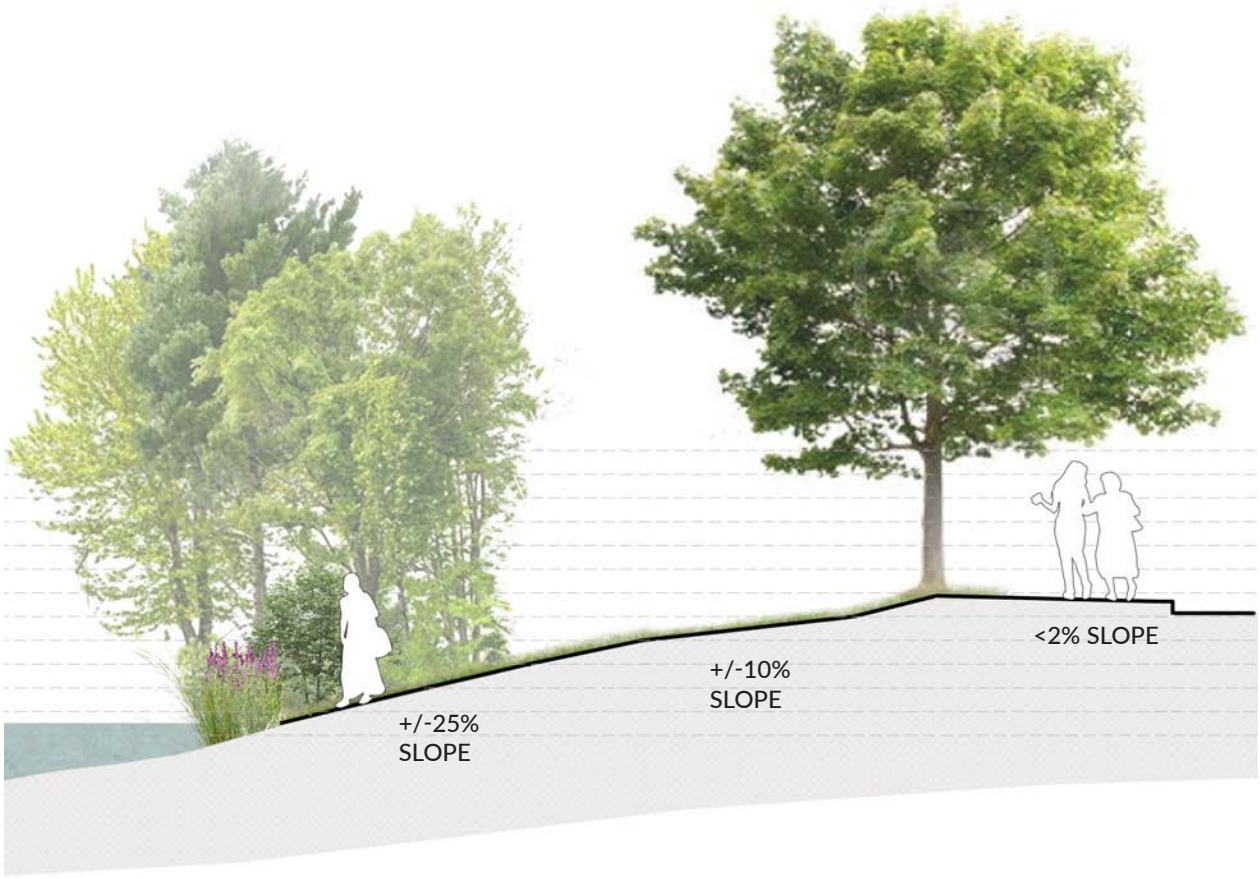

FIGURE 2.22 SLOPE BETWEEN LAKE SHORE ROAD AND THE POND EDGE
While the slope of the sidewalk along Lake Shore Road is quite shallow, the land sloping down to the pond edge is much steeper.

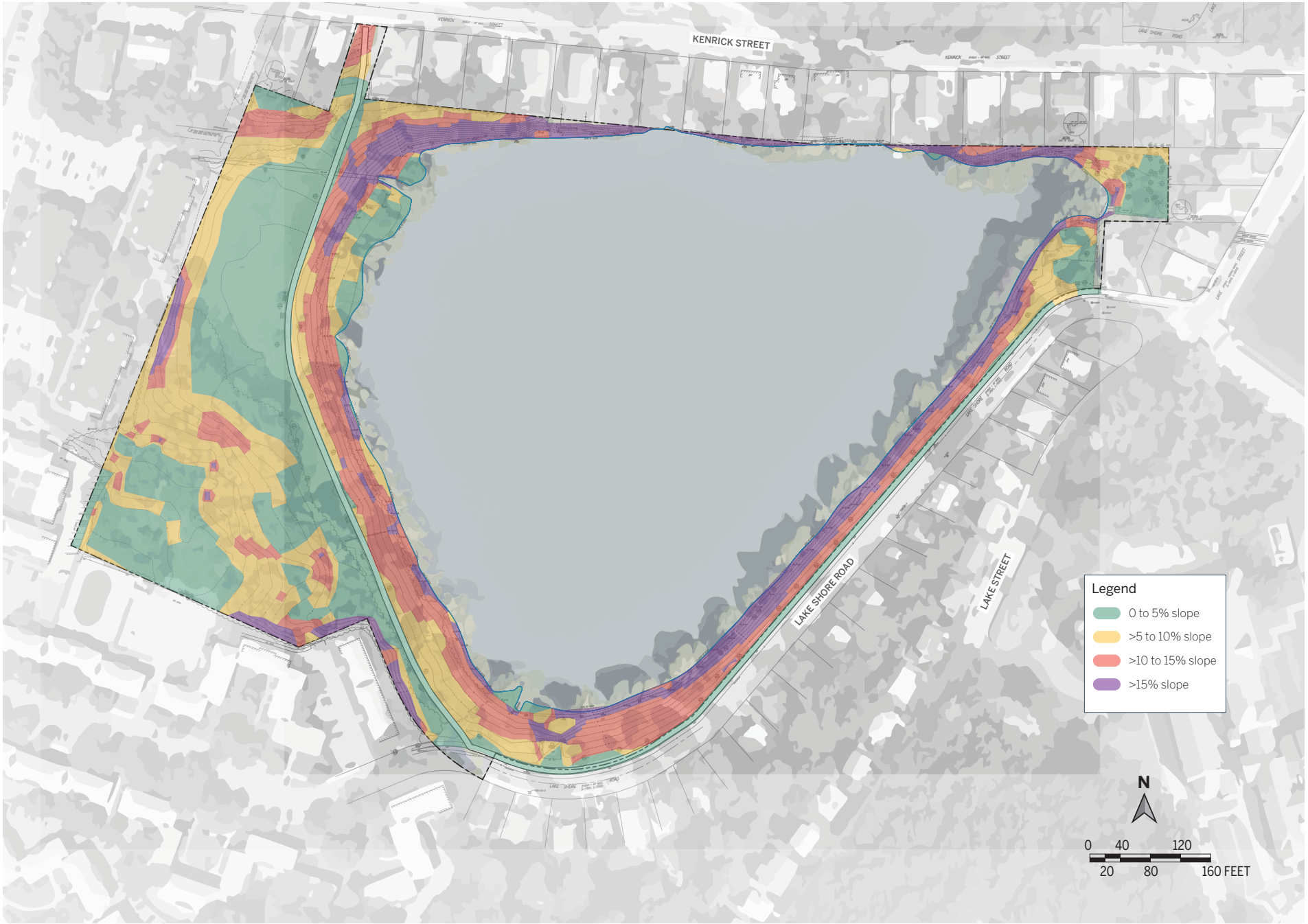

FIGURE 2.23 SLOPE OF THE LAND SURROUNDING CHANDLER POND

The slope of the land surrounding Chandler Pond plays a large role in recommendations for strategies to improve the health of the pond and increase accessibility, and well as future maintenance considerations.

OTHER CHALLENGES

Property Boundary, Encroachments, and Dumping

Here, an encroachment refers to a situation where someone or something extends beyond its legal boundaries onto the property of the park. Encroachments were observed along most edges of the property, and include things like fences, structures, pavement, stairs and docks intruding onto park property. In addition, other encroachments were more situational, such as using park property as a snow storage area, or individuals dumping debris into the woodland area.

Encroachments are often unintentional and arise for various reasons, such as inaccurate property surveys, a misunderstanding of property boundaries, or changes in the landscape over time, such as eroding shorelines.

In some cases, property owners may choose to resolve encroachments through negotiations, property boundary adjustments, or obtaining appropriate easements. In other instances, legal action may be necessary to resolve the issue.

Water Quality

The water quality in the pond is shaped by a combination of natural processes, such as the underlying types of rock and soil, and human activities and land use. In most ponds, natural factors cause few problems. The most serious water quality problems typically come from the activities or land uses surrounding the pond. Proactive testing can detect problems and help identify their source.

Given the urbanization of the area and the land uses present in the sewershed, some assumptions can be made about water quality. However, to make the most effective interventions, it is recommended that water quality data be obtained for the pond and its inlets regularly, and at different times of the year. For example, early summer sampling could identify an influx of nutrients from lawn fertilizers, while early spring or late winter sampling will provide information about the concentration of road salts making their way into the pond from stormwater runoff.

FIGURE 2.24 (AT RIGHT) EXAMPLES OF TYPICAL OBSERVED ENCROACHMENTS ONTO PARK PROPERTY

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GOALS AND OBJECTIVES

GOAL

The ultimate goal for the project is to restore, protect and manage the pond and surrounding park for maximum ecological and recreational benefits.

To reach that goal, realistic and achievable objectives need to be set, along with a set of strategies to achieve those objectives. With that in mind, the objectives for the master plan were developed considering the lessons learned from the existing conditions analysis, the public input received on priorities, and the constraints in funding and manpower.

Recognizing that meeting such an ambitious goal is only possible through a phased and extended effort, prioritization and phasing is discussed in a later chapter.

OBJECTIVES

This chapter lays out the basic framework for the objectives of the master plan, and the strategies that can achieve those objectives. More detail on proposed "on the ground" actions are covered in the following chapter.

Restore, Protect and Manage the pond and park for maximum ecological and recreational benefits

Objective 1

Stabilize the Shoreline, Preventing Erosion and Sedimentation

- Use data on slopes to guide the location of future access points, and the routes to those access points
- Plant vegetation with root systems that can improve resilience to erosion.
- Control and guide access to the shoreline

Objective 2

Remove or Limit Invasive Species, in Both Upland Areas and Along the Shoreline

- Be strategic in the removal of existing trees to minimize habitat disruption.
- Develop short and long-term protocol for tackling the invasive plant species
- Be vigilant in controlling small infestations, to keep them from becoming a larger problem

Objective 3

Improve Quality of Buffer and Woodland Areas

- Decrease the overall number and proportion of invasive species
- Re-vegetate the park with desirable species, improving wildlife habitat
- Plant only native species or nonnatives that are likely to thrive given the pressure of climate change.
- Develop planting and maintenance protocol to help the establishment of new plantings.
- Resolve encroachments

Objective 4

Improve General Water Quality in the Pond

- Establish a regular water quality monitoring program
- Increase the percentage of buffer, while decreasing the percentage of lawn
- Decompact soils for better infiltration
- Reduce the pollutant loads in the water coming into the pond through the inlets
- Evaluate outlet options for better and more consistent maintenance

Objective 5

Create Ways to Enjoy the Park and Pond while Being Ecologically Sensitive

- Develop circulation paths and access points that are sufficient for visitors and maintenance needs while protecting the shoreline
- Improve accessibility of the pond for all users, regardless of their abilities or mobility
- Develop access points that can be reinforced for foot traffic and easily maintained.
- Expand access to the woodland area of the site

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RECOMMENDATIONS

SUMMARY

To achieve the goal and objectives noted in the previous chapter, a two-pronged approach is needed to address both the physical space and how it is maintained. This chapter focuses on the design interventions, while maintenance and management issues are covered in a later chapter.

DESIGN INTERVENTIONS

Analysis of the challenges and shortfalls noted in the Existing Conditions chapter contributed to recommendations related to the physical structure of the park. The recommended design interventions fall into several broad categories that are detailed in this chapter. They include:

Improving the Vegetated Buffer

Improving the existing shoreline buffer will help to stabilize the pond edge, reduce erosion, and improve water quality. It also improves the habitat value and makes for a more enjoyable park experience.

Reducing/Removing Invasive Vegetation

The removal of invasive vegetation contributes to the improvement of the buffer and woodland areas of the park, increasing habitat value and enabling native species to thrive.

Replacement Vegetation

Introducing new desirable vegetation is a critical component of the process. Re-vegetating the site with appropriate species will help stabilize bare soils and steep slopes, keep invasive species at bay, improve water quality by assisting in soil infiltration and support a greater variety of wildlife.

Access

Access includes ensuring that site improvements comply with physical accessibility standards, providing everyone with an equal opportunity to enjoy the park's features. Access also includes safe and convenient locations along the pond's edge where visitors can enjoy the pond and its wildlife. Guiding visitors to stable access points around the pond will reduce the risk of erosion, maintain the health of the buffer and ultimately improve the visitor experience.

Inlets and Outlet Improvements

As the inlets are a major influence on water quality, we examine constructed, natural and cultural interventions that can influence water quality outcomes.

Planning for Climate Change

An over-arching theme across the master plan, climate change impacts the recommendations made with an eye to future challenges and stressors.

Objective 1
Stabilize the Shoreline, Preventing Erosion and Sedimentation

Objective 2
Remove or Limit Invasive Species, in Both Upland Areas and Along the Shoreline

Objective 3
Improve Quality of Buffer and Woodland Areas

Objective 4
Improve General Water Quality in the Pond

Objective 5
Create Ways to Enjoy the Park and Pond while Being Ecologically Sensitive

MASTER PLAN

A Improve Existing Buffer by Removing Invasives

B Plant Additional Buffer Areas

C Establish Access Points

D Maintain Key Views

E Improve (4) Inlets and Drainage

F Establish Access to an Improved Woodland

G Establish Maintenance Guidelines

H Address Vegetation Management Across Park

IMPROVING THE VEGETATED BUFFER

Buffer Benefits

To achieve the objectives of stabilizing the shoreline, improving the quality of vegetation at the park, and improving water quality, a robust and healthy vegetated buffer is recommended, A robust vegetated buffer along the shoreline of Chandler Pond would have a number of benefits, including:

Improving the ecosystem by providing habitat for desirable species, increasing the uptake of nutrients while reducing algal growth, and increasing species diversity.

Improving water quality by improving the soil's ability to infiltrate and filter runoff, stabilizing soil on steep slopes, minimizing erosion, and trapping sediment/nutrients to prevent their migration into the pond.

Controlling nuisance wildlife that decrease water quality, such as Canada geese, by maintaining vegetation at a height that discourages them from inhabiting the park.

Generally, wider buffers provide greater benefits. While every site is different, vegetated buffers of at least 25' are considered a good starting point for most applications. However, even buffers of 10' provide benefits if they are high quality[1].

Applying a uniform buffer of 25' in width around the entire pond would utilize nearly the entire area of the park along Lake Shore Road. In other places around Chandler Pond, there already is a buffer of 25' or more in place, but it isn't particularly high quality because of invasive plants, exposed soil or social trails. In other areas, there is no buffer at all beyond poor quality lawn composed of turf grass with shallow roots.

As a result, the design for the pond's edge balances recreation needs, such as picnicking, festivals and other passive recreation with the a generous vegetated buffer area.

Buffer Strategy

The overall buffer strategy is to protect and improve the vegetated buffer that already exists while extending the buffer in areas where it is most needed due to slopes, views, and other site-specific conditions.

While the buffer differs in quality across the shoreline, in most locations, some native vegetation is intermixed with invasive vegetation. Maintaining the existing native vegetation is important because it provides a place from which to start. Looking at which native plants are successfully outcompeting the invasives also provides information on what other vegetation might do well in those locations.

It was also important to have vegetated buffer in as much of the delineated wetland as possible. Healthy wetlands are some of the most diverse habitats and provide crucial water treatment functions. In addition, wetlands generally have highly organic soils that are susceptible to compaction from foot traffic.

In areas where the existing buffer was already wider than 25', the proposed plan maintains that dimension, but recommends improving the composition to remove the invasive species.

For areas of extremely steep slopes, such as the property line along Kenrick Street, complete vegetation coverage is proposed on BPRD property. The steep slopes in those locations are not sustainable without vegetation roots to stabilize the soil.

Overall, the proposed master plan includes a minimum buffer of at least 15' around the entire pond, in every location where access points are not proposed (See Section "Access" on page 49). It also includes vegetated buffer in all locations under BPRD ownership with slopes greater than 25%.

Composition of the Buffer

Buffers do not need to be uniform. They can be composed of different plant materials that give a different character to particular areas, or to serve certain maintenance or access goals. For example, trees might be appropriate where visitors would otherwise be subject to

1 Hawes, E. and Smith, M. (2005). Riparian Buffer Zones: Functions and Recommended Widths. Prepared for the Eightmile River Wild and Scenic Study Committee. https://www.hebronnh.gov/sites/g/files/vyhlif3256/f/uploads/riparian_buffer_science_yale.pdf

FIGURE 4.1 VISUALIZATION OF A 25' VEGETATED BUFFER AND VISUALIZATION OF THE REGULATORY BOUNDARIES AT CHANDLER POND

Here a 25' vegetated buffer is shown in comparison to the existing and proposed buffers around the pond. The extent of the delineated wetland is also shown, along with the regulatory 100' Buffer which governs activities under the control of the Massachusetts Department of Environmental Protection and the City of Boston.

hot summer sun, while lower grassy vegetation might be appropriate where views are a top priority.

Plant species selections vary from the water's edge and wetland areas, to drier upland areas to shadier, wooded locations. Site-specific soils and topography influence how abruptly that transition occurs, and which plants will work best.

Slopes and maintenance were also considered in the buffer recommendations. Shrubs and groundcovers are appropriate where foot traffic is being discouraged, where maintenance access is difficult or where quick establishment of a thick root zone is needed to hold steep slopes. These types of vegetation are relatively self-sustaining in that they do not typically require pruning or mowing, and their size is generally genetically limited.

Where views are a priority or where low-growing vegetation is important for safety, grasses or groundcovers are recommended. Plants can be selected that require no fertilizer and only require mowing once or twice a year once they are established. That is a significant decrease in required maintenance as compared to lawn.

Where native trees are already present, it is recommended to maintain these trees while eliminating invasive trees and shrubs and replacing removed vegetation with native trees and a native shrub understory.

FIGURE 4.2 VISUALIZATION OF THE VEGETATED BUFFER PROPOSED FOR CHANDLER POND
The vegetated buffer will provide a transition zone between the water and the lawns and pathways currently in use at the park shown,

REMOVING OR REDUCING INVASIVE VEGETATION

Invasive Impacts

Invasive vegetation threatens native vegetation through various means. Norway maples, for example, create such a dense canopy that they shade out even the most shade-tolerant understory plants, leaving bare ground exposed to erosion. Black locusts trees produce particularly large quantities of seeds, and both the mature trees and saplings have thorns, which protect them from wildlife browsing.

Oriental bittersweet, an aggressive vine, climbs trees, shading a tree's leaves and strangling the tree with its trunk. Other vegetation such as garlic mustard releases toxic chemicals through its roots that inhibit the growth of other plants in close proximity. Japanese knotweed has an extremely robust root system, and can thrive in a variety of conditions, sun or shade, dry or wet, outcompeting native vegetation.

Some species produce a large amount of seeds, have seeds that are particularly tasty (even if nutritionally low-value) to birds, or have seeds that can lay dormant for a decade or more, waiting for the conditions to be right for germination. Invasive plants also often physically overwhelm native plants, adding to an overgrown, overly-shaded, and unmaintained appearance.

Even with their significant downsides, invasive vegetation does provide some limited benefits, including habitat and cover for birds and small mammals, as well as shading which can help to cool the pond, and provide a respite for people and wildlife on hot days.

Since one of the goals of invasive species management is to improve habitat, invasive removal should be directly followed by re-vegetation efforts to maintain robust habitat and food sources. Re-vegetation is also important because bare ground is a prime location for new invasive species to take hold. Re-vegetation is covered later in this chapter.

The strategies for removing, or at least reducing, the invasive species at Gallagher Park differ somewhat depending on whether the target species is a tree, or woody/herbaceous understory plants. In either case, a combination of approaches is recommended. Additional information on maintenance options and monitoring is covered in later chapters.

Finally - monitor the Massachusetts Prohibited Plant List for updates. It is revised periodically.

Invasive Tree Strategy and Prioritization

Priority 1:
Prevention: Review areas for invasive species that may are becoming established. This could mean new invasive species, or new sighting of invasive species that are already present elsewhere on the property. Entrances and property boundaries are key places to focus these efforts.

Priority 2:
Removal: In areas with an isolated or small population of invasive trees, remove the tree and all of its saplings. This ensures that a small problem does not become a widespread problem.

Priority 3:
Break the Cycle: In areas where primarily native trees dominate, remove saplings of all invasive trees, and all mature invasive trees, as long as the capacity exists to replant the areas where the invasive trees are removed. Otherwise, remove seedlings and saplings, while leaving the mature trees in place until resources permit their removal and re-vegetation efforts.

This approach strives to improve existing medium to high quality areas, which already prove to be suitable places for native species to thrive. The proactive removal of invasive seedlings and saplings prevents the next generation from taking hold. Often seedlings and saplings are small enough to be hand-pulled by volunteers. However, hand-pulling should be done with supervision, since timing and soil moisture levels are key to limiting soil disturbance. For the most effective eradication, physical removal is best paired with professional herbicide treatment.

Priority 4:
Transition: In areas where invasive trees dominate, remove all saplings of invasive trees, and remove 5-15% of the invasive mature tree population at each cycle. A higher percentage of removals favors the viability of new replacement plantings and can help maintain

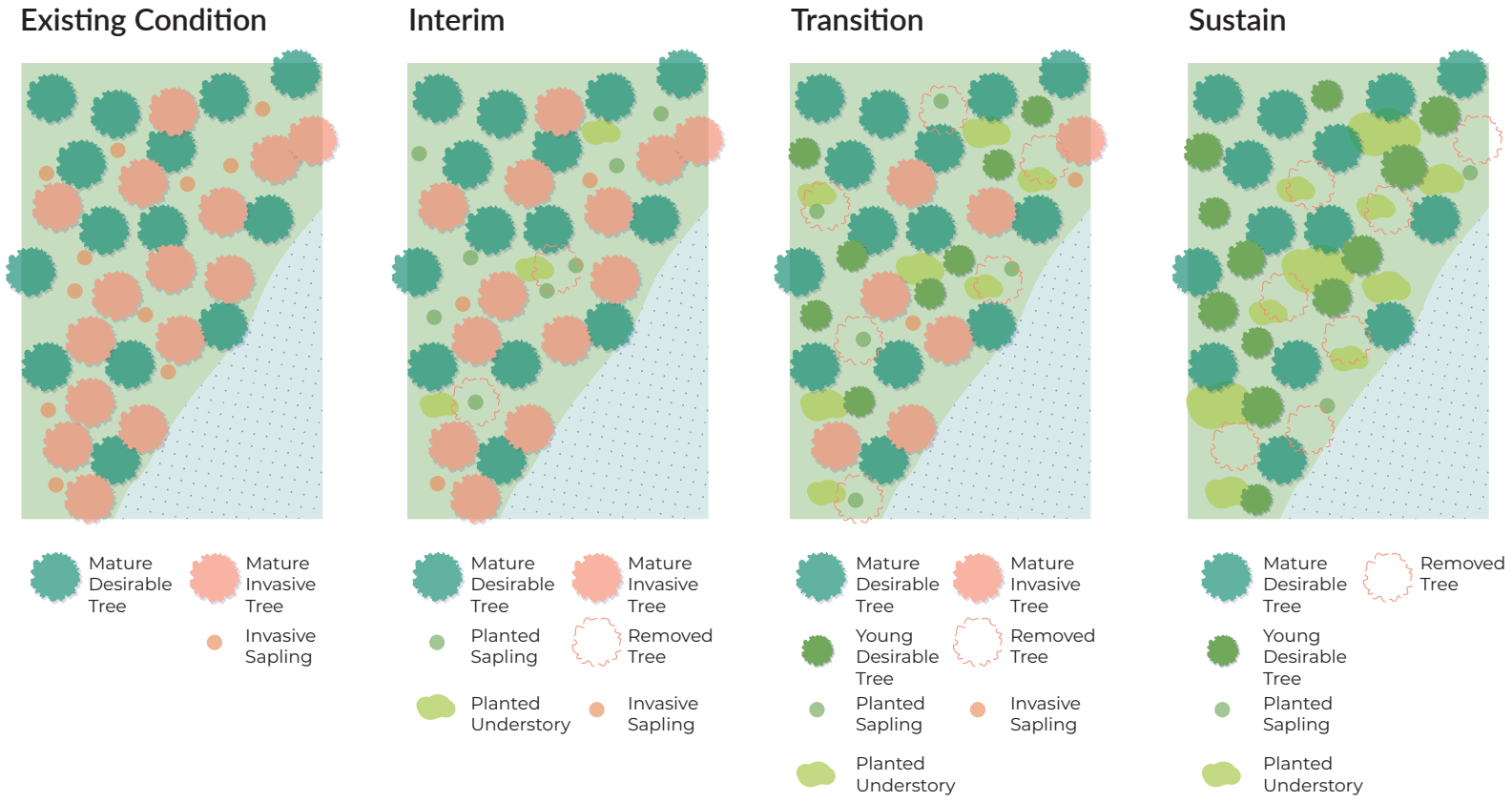


FIGURE 4.3 TRANSITIONING FROM AREAS DOMINATED BY INVASIVE TREES TO AN AREA DOMINATED BY NATIVES
Timeline for this transition is dependent on funding and vigilance. Removing invasive seedlings and saplings in an ongoing way will help break the cycle.

project momentum. However, removals may be limited by permitting approvals, funding, labor, or other factors. If funding allows, cycles should be conducted annually. With longer cycles, continued removal of saplings will keep the number of mature invasive trees from increasing.

This approach creates a way to start improving moderately to severely degraded areas, while maintaining the ecological functions that all trees provide. Proactively removing seedlings and saplings of invasive trees prevents the next generation from taking hold.

By staggering removals, future plantings will also avoid the problems of even-aged stands. When trees in an area are all of the same age, there is a lack of the habitat diversity found naturally. Even-aged tree plantings can lead to future problems when their maintenance demands coincide or when large expanses of trees experience natural mortality in a short time period.

Invasive Shrub and Herbaceous Vegetation Strategy and Prioritization

Priority 1:

Prevention: Review areas for invasive species that are becoming established. This could mean new invasive species, or new locations of invasive species that are present elsewhere on the property. Entrances and property boundaries are key places to focus these efforts.

Priority 2:
Removal: Tackle small populations of the most aggressive species before they establish a strong foothold. For example, remove small areas of knotweed, as they can quickly become a larger colony in just a single growing season.

Priority 3:
Improve the Odds for Natives: Focus on invasive species that not only out-compete, but actively hamper the success of existing native species. This includes species such as Oriental Bittersweet, which can take down existing, mature, native vegetation. This category also includes species that are aleopathic, meaning that they produce toxins that interfere with the ability of other species to grow nearby.

Priority 4
Contain: Ensure that larger populations of the most aggressive species are kept in check to avoid further spread. As resources allow, focus on addressing these populations that require multiple years of treatment.

Priority 5
Protect Natives: Protect existing and new native plantings. Over the last decade, native plantings have been added to select areas of the park. To maintain those gains, ensure that any invasive plants encroaching on these areas are cleared, or at least kept in check.

Woodland Invasive Vegetation Strategy and Prioritization

Invasive removal in the wooded areas of the property should follow the same strategies for invasive trees and shrubs as described above. Given the significant total area, and proximity to property boundaries and ongoing encroachments, it is advantageous to add an additional layer of consideration based on geography.

Conduct removals progressively, moving from the park-side edge of the wooded areas toward the property boundary. There may always be some invasive species present along the property edges if neighboring property owners or managers do not completely remove the invasive species on their properties.

The exception to this general guideline is knotweed. With knotweed's highly aggressive nature, those colonies should be treated as soon as possible after their discovery, regardless of their location. Treatment could mean eradication, or it could mean stopping its spread, such as with cutting and bagging.

A Note on Nuisance Species

A number of nuisance species are present in the park including poison ivy and black willows. Both are native, but poison ivy causes skin irritation, and the black willows' prolific re-sprouting can block key views and cause shoreline creep. Treatment of nuisance species should not take precedence over the identified invasive species. As resources allow, and conservation authorities permit, remove nuisance vegetation in high-visitation areas and at access points, particularly where it endangers visitors' safety.

FIGURE 4.4 LOCATION-BASED INVASIVE TREATMENT STRATEGY FOR THE WOODED AREAS OF THE PARK
Conduct invasive removals from the park-side edge of the wooded areas, inward. The exception would be stands of knotweed, which are highly aggressive. Treat knotweed wherever it is found.

REPLACEMENT VEGETATION

As the invasive species in the park are removed, improve the quality of the remaining vegetation by expanding the buffer and re-vegetating cleared areas. This limits the amount of time that bare soil is exposed, reducing erosion and helping to prevent invasive species from getting re-established.

Plant selection is key to the success of re-vegetation efforts. Criteria for plant selection include the typical considerations for light levels, soil pH, hardiness zone and soil moisture. However, the site also requires species that are adaptable and low maintenance. Steep slopes around much of the pond means that the soil conditions can change from wet to dry over small distances, or change substantially between seasons. Limited access and limited resources for upkeep are also considerations.

In general, preference should be given to native plants over non-native plants. While definitions of native vs. non-native (or introduced) vary, this document follows the classification of the USDA PLANTS database. Native plants, since they are adapted to local conditions generally require less water, fertilizer, pesticides, time and money to maintain, when compared to non-native or exotic species. Also, native wildlife and native vegetation have evolved to support each other, and in some cases - to heavily rely on each other. For example - Monarch butterflies depend on milkweed plants for survival. Finally, non-native plants tend to have lower resource value for birds, insects and other local wildlife.

Climate change means that a complete reliance on native species may not achieve the desired outcome. The lifespan of trees, in particular, is long enough that consideration must be given to what conditions are expected in 50-100 years. With the uncertainty of which species will be able to adapt in time to keep up with the changing climate, it is advantageous to look to plants native to areas that are historically warmer than Massachusetts to understand what vegetation might thrive here in the coming decades.

More information on the impacts of climate change on the master plan recommendations are included later in this Chapter.

Buffer Replacement Vegetation

As noted in the section “Improving the Vegetated Buffer” above, vegetation can vary within the buffer to facilitate different activities or create different characters. The composition of the vegetation will change relative to the transition from the water’s edge to drier, upland areas.

Lists of recommended vegetation follow. While these are not comprehensive lists of every single species that could be used, they do include common, low-maintenance plants that are traditionally found in the different planting zones, and that have a history of being successfully used in restoration projects.

Species with a * are particularly effective at erosion control. Species with a # are not native to Massachusetts, but are recommended as near-native species that will help mitigate the impact of climate change on the park’s vegetation by incorporating plants that are native to areas just further south, and that have a tolerance for variable soil conditions.

Emergent Zone

Shrubs

Buttonbush (*Cephalanthus occidentalis*) *

Herbaceous

Arrow Arum (*Peltandra virginica*)
Arrowhead or Duck Potato (*Sagittaria latifolia*)
Pickerelweed (*Pontederia cordata*)
Rushes (*Juncus spp.*) *
Sedges (*Carex spp.*) *
Soft-stem bulrush (*Schoenoplectus tabernaemontani*) *
Sweetflag (*Acorus americanus*)
Water Plantain (*Alisma subcordatum*)
Woolgrass (*Scirpus cyperinus*) *

Wetland Zone

Trees

Atlantic White Cedar (*Chamaecyparis thyoides*)
Blackgum, Sourgum (*Nyssa sylvatica*) *
Pin Oak (*Quercus palustris*)
Red Maple (*Acer rubrum*) *
River Birch (*Betula nigra*)
Serviceberry (*Amelanchier canadensis*)
Speckled Alder (*Alnus rugosa*)
Swamp White Oak (*Quercus bicolor*)
White Oak (*Quercus alba*)

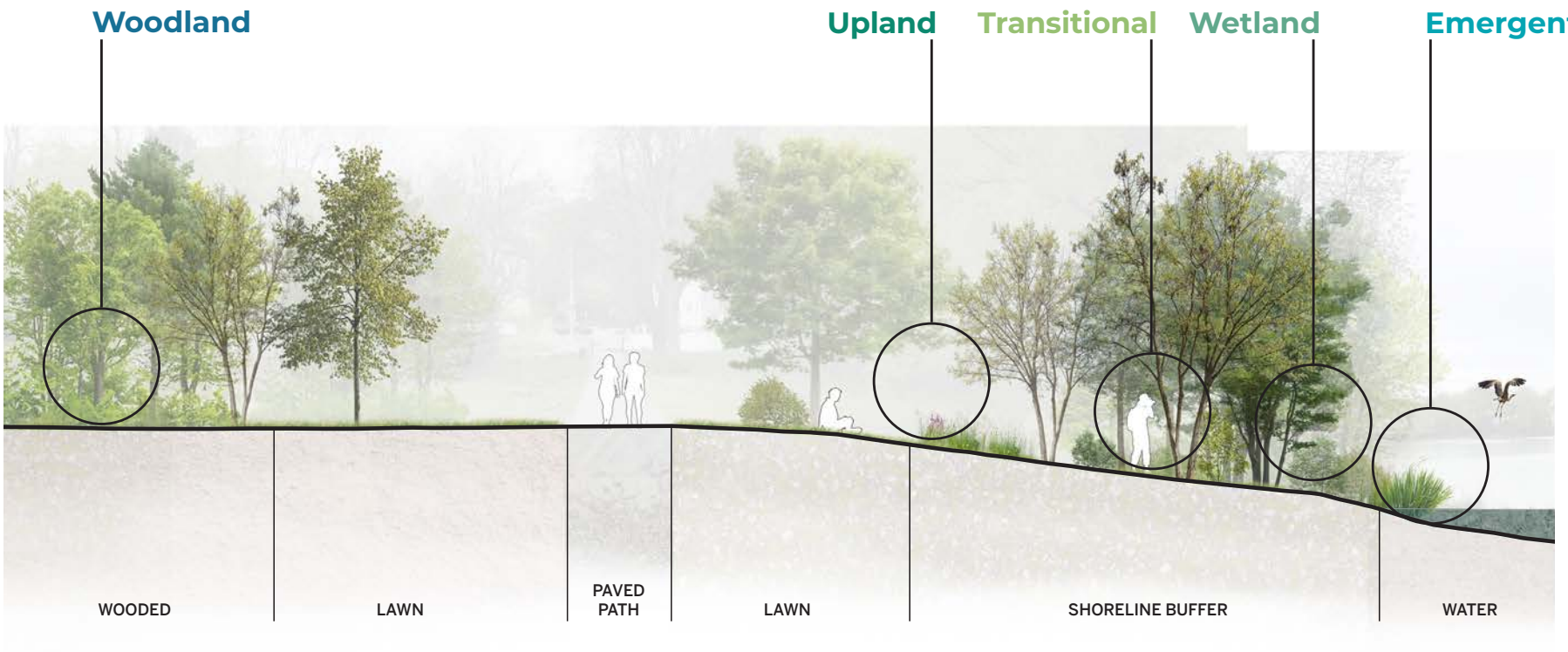


FIGURE 4.5 RE-VEGETATION ZONES
Illustration of the different zones used for categorizing vegetation

Shrubs
Arrowwood Viburnum (*Viburnum dentatum*)
Buttonbush (*Cephalanthus occidentalis*) *
Common Spice Bush (*Lindera benzoin*)
Elderberry (*Sambucus canadensis*) *
Gray Dogwood (*Cornus racemosa*) *
Highbush Blueberry (*Vaccinium corymbosum*)
Inkberry (*Ilex Glabra*) *
Marsh Hibiscus (*Hibiscus moscheutos*)
Meadowsweet (*Spirea latifolia*) *
Red-Osier Dogwood (*Cornus sericea*) *
Silky Dogwood (*Cornus amomum*) *
Steeplebush (*Spiraea tomentosa*) *
Swamp Azalea (*Rhododendron viscosum*)
Swamp Rose (*Rosa palustris*)
Sweet Pepperbush (*Clethra alnifolia*) *
Winterberry (*Ilex verticillata*) *

Herbaceous
Beardtongue (*Penstemon digitalis*) *
Blue Flag Iris (*Iris versicolor*)
Blue Vervain (*Verbena hastata*) *
Boneset (*Eupatorium perfoliatum*) *
Cardinal Flower (*Lobelia cardinalis*)
Joe Pyeweed (*Eutrochium purpureum*)
March Marigold (*Caltha palustris*)
Monkey Flower (*Mimulus ringens*)
New England Aster (*Symphyotrichum novae-angliae*) *
Ostrich Fern (*Matteuccia struthiopteris*) *
Royal Fern (*Osmunda regalis*)
Sedges (*Carex spp.*)
Sensitive Fern (*Onoclea sensibilis*)
Soft Rush (*Juncus effusus*) *
Soft-stem bulrush (*Schoenoplectus tabernaemontani*) *
Spotted Joe-pye weed (*Eupatorium maculatum*)
Swamp Milkweed (*Asclepias incarnata*)
Turtlehead (*Chelone glabra*) *
Wild red columbine (*Aquilegia canadensis*)
Woolgrass (*Scirpus cyperinus*) *

Some common wetland species already present along the shoreline and are not included in this list, including black willows and silver maples. Black willows are present in an overabundance, so further plantings are not warranted. Silver maples are weak-wooded and have a tendency to break apart so they are not recommended for additional plantings.

Transition Zone

Trees

Blackgum, Sourgum (*Nyssa sylvatica*) *
Pin Oak (*Quercus palustris*)
Red Maple (*Acer rubrum*)
Red Oak (*Quercus rubra*)
Shadowbush, Serviceberry (*Amelanchier canadensis*)
Sugar Maple (*Acer saccharum*)
Swamp White Oak (*Quercus bicolor*)
Sweetgum (*Liquidambar styraciflua*)
Tulip Tree (*Liriodendron tulipifera*)
White Oak (*Quercus alba*)
Witch Hazel (*Hamamelis virginiana*) *

Shrubs

Arrowwood Viburnum (*Viburnum dentatum*)
Black Chokeberry (*Aronia melanocarpa*)
Common Spice Bush (Lindera benzoin)
Elderberry (Sambucus canadensis)
Gray Dogwood (Cornus racemosa)
Inkberry (Ilex Glabra)
Mapleleaf Viburnum (*Viburnum acerifolium*)
Meadowsweet (*Spiraea latifolia*) *
Red-Osier Dogwood (*Cornus sericea*)*
Sweet Fern (*Comptonia peregrina*) *
Sweet Pepperbush (*Clethra alnifolia*)
Winterberry (*Ilex verticillata*)

Herbaceous

Alumroot (*Heuchera americana*) #
Downy Skullcap (*Scutellaria incana*) #
Little Bluestem (*Schizachyrium scoparium*) *
New England Aster (*Symphyotrichum novae-angliae*) *
Orange Coneflower (*Rudbeckia fulgida*) #
Sensitive Fern (*Onoclea sensibilis*)
Switchgrass (*Panicum virgatum*) *
Zigzag Goldenrod (*Solidago flexicaulis*)

Upland Zone

Trees

Chokecherry (*Prunus virginiana*)
Eastern Red Cedar (*Juniperus virginiana)*
Grey Birch (*Betula populifolia*)
Red Maple (*Acer rubrum*)
Tulip Tree (*Liriodendron tulipifera*)
White Oak (*Quercus alba*)
White Pine (*Pinus strobus*)
Witch Hazel (*Hamamelis virginiana*) *
Yellow Birch (*Betula alleghaniensis*)

Shrubs

Gray Dogwood (*Cornus racemosa*)
Mapleleaf Viburnum (*Viburnum acerifolium*)
New Jersey Tea (*Ceanothus americanus*)
Ninebark (Physocarpus opulifolius)
Shrubby St. John's Wort (*Hypericum prolificum*)
Sweet Fern (*Comptonia peregrina*) *

Herbaceous

Butterfly weed (*Asclepias tuberosa*) *
Christmas Fern (*Polystichum acrostichoides*) *
Large-Flowered Tickseed (Coreopsis grandiflora) #
Little Bluestem (*Schizachyrium scoparium*) *
Orange Coneflower (*Rudbeckia fulgida*) #
Partridge Pea (*Chamaecrista fasciculata*) *
Purple Coneflower (*Echinacea purpurea*) #
Switchgrass (*Panicum virgatum*) *
White wood aster (*Eurybia/Aster divaricatus*)

Woodland Replacement Vegetation

Proposed replacement vegetation for the woodland overlaps somewhat with upland vegetation. Understory woodland plantings typically prefer more shade than upland species. Both moist and dry area of woodland areas exist on the site, due to topography. Plants should be chosen with this impact in mind.

The existing woodland area, particularly in the southwest corner of the property contains some well-established tree species (black cherry, choke cherry, pin oak, and white pine) that serve as the basis for the woodland plant palette. In addition, concerns about sight lines, visibility, and maintenance guided the decision to propose primarily trees and low woody or herbaceous vegetation for the woodland.

Woodland Zone

Trees

Black Cherry (*Prunus serotina*) (*use with caution, can self seed and is somewhat disease-prone*)
Blackgum, Sourgum (*Nyssa sylvatica*)
Choke Cherry (*Prunus virginiana*)
Swamp White Oak (*Quercus bicolor*)
White Pine (*Pinus strobus*)
Witch Hazel (*Hamamelis virginiana*) *

Emergent/Wetland Plants

CORNUS AMOMUM
SILKY DOGWOOD

CEPHALANTHUS OCCIDENTALIS
BUTTONBUSH

LINDERA BENZOIN
SPICEBUSH

LOBELIA CARDINALIS
CARDINAL FLOWER

CAREX VULPINOIDEA
FOX SEDGE

Transitional Plants

AMELANCHIER CANADENSIS
SHADBLOW

VIBURNUM DENTATUM
ARROWWOOD

SPIRAEA LATIFOLIA
MEADOWSWEET

PANICUM VIRGATUM
SWITCHGRASS

SOLIDAGO FLEXICAULIS
ZIGZAG GOLDENROD

Upland Plants

LIRIODENDRON TULIPIFERA
TULIPTREE

JUNIPERUS VIRGINIANA
EASTERN RED CEDAR

CEANOTHUS AMERICANUS
NEW JERSEY TEA

SCHIZACHYRIUM SCOPARIUM
LITTLE BLUESTEM

AESCLEPIAS TUBEROSA
BUTTERFLY WEED

Woodland Plants

QUERCUS BICOLOR
SWAMP WHITE OAK

EURYBIA DIVARICATA
WHITE WOOD ASTER

RHODODENDRON MAXIMUM
GREAT RHODODENDRON

PENSTEMON DIGITALIS
WHITE BEARDTONGUE

EURYBIA DIVARICATA
WHITE WOOD ASTER

FIGURE 4.6 RE-VEGETATION ZONES - SAMPLE VEGETATION
Examples of the vegetation that could be used in restoration efforts in each zone.

Photo: SumCo-Eco Contracting

Photo: Kyle Zick Landscape Architecture

FIGURE 4.7 EXAMPLE OF OVERHEAD HERBIVORY FENCING (LEFT) AND PLANT ESTABLISHMENT FENCE (RIGHT)
Fencing provide enough time for new plantings to get established without interference by humans or grazing geese. Overhead fencing uses strings and mylar tape to deter geese from landing. In-ground fencing protects new plantings from humans and some grazing wildlife. Raising the fence several inches above ground level permits amphibians and reptiles to move through the fencing, but also reduces protection from small mammals, such as rabbits.

Shrubs
Black chokeberry (*Aronia melanocarpa*)
Common Spice Bush (*Lindera benzoin*)
Great Rhododendron (*Rhododendron maximum*)
Mountain Laurel (*Kalmia latifolia*)
Sweet Pepperbush (*Clethra alnifolia*)

Herbaceous
Alumroot (*Heuchera americana*) #
Beardtongue (*Penstemon digitalis*) *
Christmas Fern (*Polystichum acrostichoides*) *
Foamflower (Tiarella cordifolia)
New England Aster (*Symphyotrichum novae-angliae*) *
Oak Sedge (*Carex pensylvanica*)
Ostrich Fern (*Matteuccia struthiopteris*)
White Wood Aster (*Eurybia/Aster divaricatus*)
Wild Red Columbine (*Aquilegia canadensis*)
Wild Ginger (*Asarum canadense*)
Woodland Stonecrop (Sedum ternatum) #
Zigzag Goldenrod (*Solidago flexicaulis*)

Fencing and signage

Monitoring and adaptive management of any type of fencing are important to ensure the desired outcomes are being met. Protective fencing and signage demonstrates a commitment to the long-term success of the ecological restoration of the park and pond. They can help to build ecological resilience, prevent negative impacts, educate visitors, and maintain a balance between conservation goals and public access.

Protective Fencing

In areas with active site restoration and re-vegetation, protective fencing and signage can contribute to the long-term health and viability of the new plantings. Fencing protects new vegetation from human and animal disturbance, preventing the creation of new social trails and reducing grazing by wildlife. The fencing allows the vegetation enough time to become established and develop a deep and robust root system, both of which will help the plants tolerate disturbance when the fencing is removed.

Temporary vegetation fencing also mitigates soil erosion by guiding foot traffic away from sensitive areas, preventing trampling and soil

compaction, which helps to restore the soils' ability to infiltrate runoff.

It is recommended that fencing be raised 4"-6" above ground level if the movement of reptiles and amphibians are a concern. While this could increase predation of new vegetation by small mammals, that concern should be balanced against the habitat and migratory needs of other wildlife.

Overhead Exclusion Fencing

Overhead geese exclusion is another aspect of fencing. Overhead herbivory fencing uses mylar strips and strings to deter geese from landing and grazing in specific areas by creating a visual and physical barrier above the vegetation, creating an obstacle that makes the area less appealing to geese. This non-lethal method avoids harm to the geese, but encourages them to seek other feeding locations. The fencing can be used as a temporary measure or a long-term strategy to deter geese, though it has some aesthetic downsides in natural areas.

Geese are known to be voracious herbivores and can quickly strip vegetation, pull young plants out of the ground, and contribute to soil compaction through their activities. Excessive grazing by geese will degrade habitats and can quickly destroy areas of newly planted herbaceous plants.

Overhead exclusion fencing can be effective, but typically requires some minimal maintenance over time to keep the system in good working order, especially in windy areas or areas with large fluctuations in water levels. Good maintenance also ensures that strings and mylar tape don't become a trash problem.

Signage

Signage can inform visitors about the ecological significance of the restoration area and guidelines for visitor behavior, emphasizing the need to avoid trampling, picking plants, or disturbing wildlife. Signage should highlight the fragile state of re-vegetation areas and the potential consequences of unwanted actions, helping to reduce unintentional damage.

Signage can also be used to invite the community to participate in the restoration effort as volunteers or advocates, fostering a sense of ownership and stewardship.

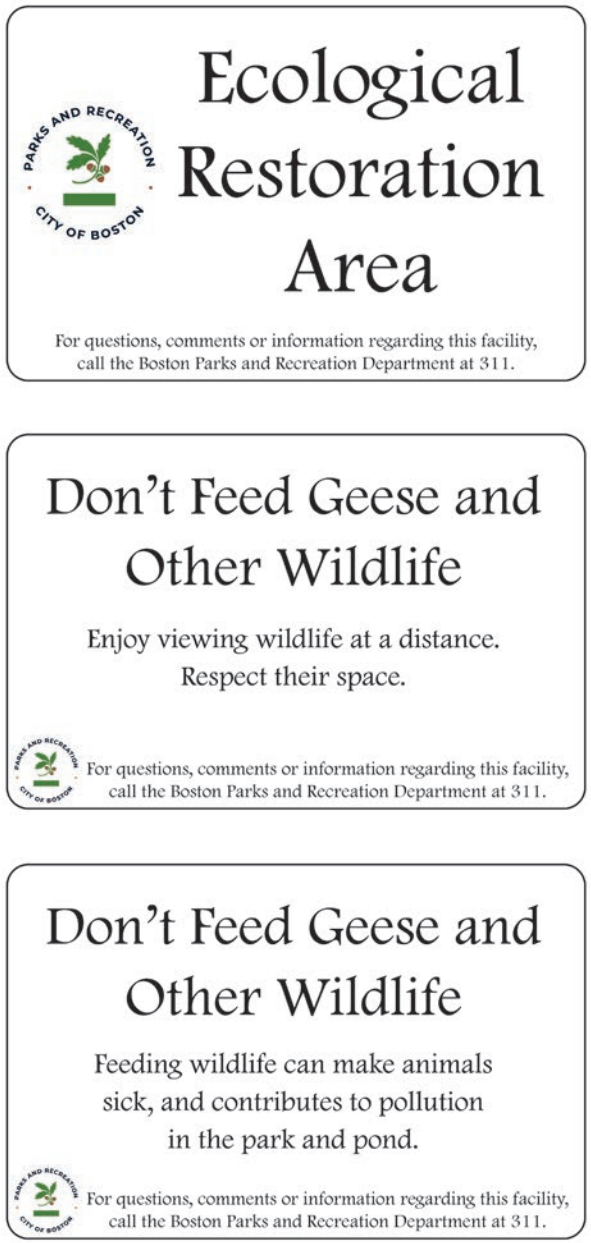


FIGURE 4.8 EXAMPLES OF EDUCATIONAL SIGNS
Signage can help identify areas where re-vegetation is underway and discourage the support of nuisance wildlife.

ACCESS

Accessibility

Amenities should be accessible to people of all abilities, including those with mobility challenges. BPRD's policy is that all new park features must be accessible and meet the requirements of the Americans with Disabilities Act (ADA). The paths must be firm, stable and slip-resistant, and have longitudinal slopes that do not exceed 5%. At Chandler Pond, this may include gently sloping paths, hard paved surfaces, or other accommodations to ensure inclusivity. Walkways with a slope between 5% and 8.33% are considered ramps and would require landings and handrails. Given the incongruous effect of handrails in a natural area, we recommend pathway slopes be maintained below 5%.

Pond Access Points

Access points refer to designated locations where people can safely and conveniently approach the pond's edge. Well-designed access points can enhance the overall experience of visitors while fostering a greater appreciation for the importance of preserving the pond's valuable natural resources

To improve the stabilization of the shoreline and increase access to the pond in a way that is sensitive to the environment, the master plan recommends defining and constructing reinforced access points.

Currently, the way visitors access the pond's edge causes erosion, leading to sedimentation and pollution of the pond.

Ideal access points will be safe, reinforced to manage foot traffic, easily maintained, and delineated so that the pond edge is protected and visitors can still enjoy the amenities and benefits that they are seeking.

When selecting proposed areas for access points, we considered:

- Areas with good views
- Areas near park entrances, where visitors are drawn to the water/views
- Distribution of access points across the site
- Accessibility concerns and natural slopes
- The vulnerability of wetlands
- Maintenance requirements and limitations

Access Points and Geese

While access points are intended to be inclusive and available for people of all abilities, it is important to avoid creating access points that encourage non-native wildlife, such as Canada geese from taking up residence in these spaces. Canada geese are not native to Massachusetts. While they are a recognizable and popular bird, they are a detriment to efforts to create a healthy pond. Canada geese eat shoreline vegetation by pulling plants out at the roots, killing the vegetation. They also create a large volume of waste, which pollutes the pond. In general, Canada geese prefer ponds with gentle slopes where they can move from areas with low vegetation (such as lawn) directly to the water, easily and quickly. They are less likely to be found in areas with taller, more dense vegetation, because that vegetation obscures their line of sight and leaves them vulnerable to predators. The geese also prefer gently sloping ground. They do not navigate abrupt changes in elevation very well.

To avoid encouraging the geese to make Chandler Pond their home, access points should not create direct sight lines from the water to the turf areas. Elevated access points can be utilized to interfere with the geese's ability to get onto the shoreline. These characteristics will help to discourage the geese from using Chandler Pond as a permanent habitat, avoiding pollution and cultural challenges

Access Point Types

Due to the different slope and vegetative cover, different strategies are needed for different site conditions. Where an area is relatively flat, an at-grade access point can be used to allow people to get closer to the water. Those access points can also be less 'constructed''and made of more natural materials, since they do not have the added pressure of steep slopes exacerbating erosion.

Access points which are at locations of steep slopes will require some sort of reinforcement to maintain the stability of the shoreline. Examples are coir logs, cut trees (such as black locust), or even a constructed platform. Three general schemes are proposed for access points.

FIGURE 4.9 TYPES OF ACCESS POINTS
Illustration of the variety of access points recommended for implementation at Chandler Pond.
A - Boulder-Reinforced

A - Boulder-Reinforced

Strategically-placed boulders, can serve both functional and aesthetic purposes, allowing people a place to rest while minimizing erosion and protecting the shoreline. Boulders can be set into the shoreline to create a way to reinforce a viewing location, decrease erosion, and reduce the trampling of vegetation, all while blending into the natural environment.

Placing boulders near the pond's edge gives people a place to stand, stop, and sit, without disturbing the natural shoreline. They can also be used can create a series of stepping stones. The boulders can also act as a natural sort of barrier, subtly deterring people from moving beyond their boundary.

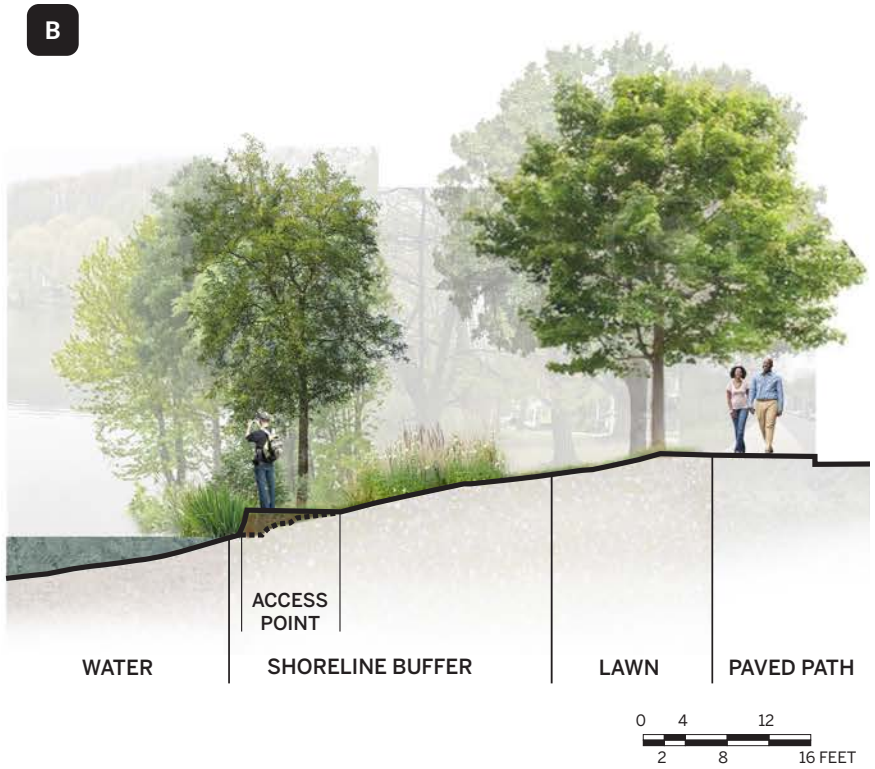
Boulders at the edge of the shoreline help to create sheltered spaces and niches for various critters, such as amphibians and small mammals. They also create obstacles to geese accessing the shoreline, as geese do not adapt well to abrupt elevation changes.

Access points utilizing boulders should use locally-sourced stones that blend with the existing landscape. Roxbury puddingstone is one type of rock that would commonly be found in the Brighton area. Boulders should be placed in a way that compliments the pond's shoreline and does not obstruct water flows. On mildly eroded slopes, soils can be backfilled behind boulders to help restore a more natural slope.

B - Log/Coir Log-Reinforced

Cut tree logs or coir logs can be used to create access points in an environmentally sustainable way. Coir logs, also known as coconut fiber logs or coir rolls, are biodegradable erosion control products made from coconut husk fibers. Cut tree logs can be re-used from certain invasive species that are cut down on the site. Black Locust, for example, is a highly rot-resistant wood that is both invasive and plentiful around the pond's perimeter, particularly in the northeast quadrant.

Cut tree logs and coir logs can help stabilize shorelines, prevent erosion, and create built-up access points for people to approach and enjoy the pond. The logs serve as a foundation for an



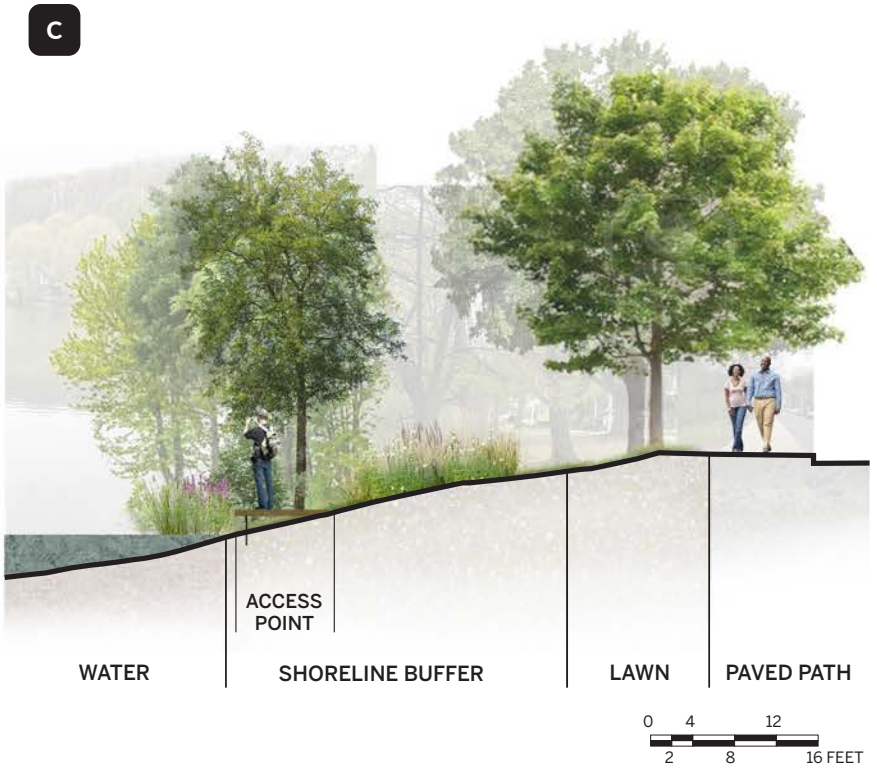


FIGURE 4.9 TYPES OF ACCESS POINTS (CONTINUED)
Illustrations of the variety of access points recommended for implementation at Chandler Pond.
B - Log/Coir Log-Reinforced
C - Raised Platform

access point, laid parallel to the shoreline, with soil backfilled behind them to make a stable viewing or gathering area that resists the earth sloughing into the pond.

If the shoreline is more severely eroded, or is unstable, tree logs and coir logs can also be stacked vertically to make a small wall, protecting the pond's edge. Cut or fallen tree logs provide a stable surface quickly, and if using rot-resistant wood, can last 30 years or more. Coir logs are biodegradable, and while their lifespan varies, they typically break down within 2-5 years. Coir logs must be vegetated to retain their erosion control properties. The vegetations' roots and the organic matter in the coir log hold the soil in place long-term. While tree logs have a longer life span, coir logs are more lightweight and easier to handle, making them easier to install on challenging slopes. Tree and coir logs on the pond's edge can provide additional habitat for aquatic organisms such as amphibians and fish. Leftover fallen or cut tree logs can be used as natural benches or seating areas near the pond, particularly if set into the slope and properly secured on steeper grades, where they can take up some of the grade change.

With coir logs and fallen or cut trees, proper installation and placement is key to the success of this type of access point.

C - Raised Platform

Raised platforms can provide unique and accessible access points on a pond, offering

visitors an elevated perspective of the water and its surroundings while minimizing direct impacts on the pond's ecosystem. Raised platforms are generally less rustic and natural-looking, although they can be designed to fit in with the environment. A raised platform is the most expensive of the types of access points recommended here.

With raised platforms, visitors utilize an elevated surface for viewing the pond. This allows people to appreciate the pond's natural beauty without disturbing the shoreline or aquatic life. This type of access point is most appropriate for the areas with the steepest shoreline, as it does not rely on regrading the ground surface to create a level access point.

This style of access point likely provides the greatest preservation of the shoreline because any direct access to the water's edge is minimized, reducing the risk of erosion and the trampling of sensitive shoreline vegetation.

While wooden boardwalk-style platforms are a traditional choice, metal grates or fiberglass slatted surfaces can meet accessibility requirements while also allowing light and water to reach the area below the platform, minimizing ecological disturbance. Accessible walkways to the platforms would be needed to ensure inclusivity.

Another benefit of the raised platform access point is that they can be constructed with minimal excavation, if certain types of piers are used. This is particularly valuable in wetland

FIGURE 4.10 EXAMPLES OF TYPES OF ACCESS POINTS
Real-life examples of the variety of access points recommended for implementation at Chandler Pond.
A - Boulder-Reinforced
B - Log/Coir Log-Reinforced
C - Raised Platform

areas where soils are delicate, and the goal is to minimize disturbance. Raised structures would also be long-lasting, having a lifespan of between 15 and >50 years, depending on the materials used.

With careful planning and responsible construction, raised platforms can offer unique and enjoyable access points on a pond while preserving the pond's ecological integrity and enhancing the overall visitor experience.

Other Considerations

Construction of any access point will require review by regulatory authorities, including the Boston Conservation Commission. Engaging with landscape architects, engineers, and environmental professionals can help ensure that the design is ecologically sound and complements the pond's natural environment. Platforms likely have additional regulatory requirements if they reach into or over the water.

Approach to Access Points

The pathway to the access points is as important as the access points themselves. A pathway that goes straight down a steep slope will erode quickly, and the material of the path is important, both for accessibility and for managing stormwater.

Signage could be helpful to reinforce the identification of pathways. Providing educational signs or interpretive panels at access points can enhance visitors' understanding of the pond's ecology, history, and wildlife, and get visitors invested in its protection.

At access points adjacent to gentle slopes, the approach pathway can be a relatively direct route. The concern in their design is accessibility and deterring unwanted wildlife. To deter geese, it is recommended that access points be backed by vegetation (minimum 2'-3' high) to ensure geese do not have a direct line of sight from the water to the lawn.

The approaches to the access points at the base of steep slopes are envisioned as winding approaches or as zigzag-style paths. Paths that approach an access point at an angle, instead of straight down a steep slope, can achieve the more gentle slopes needed to meet ADA requirements.

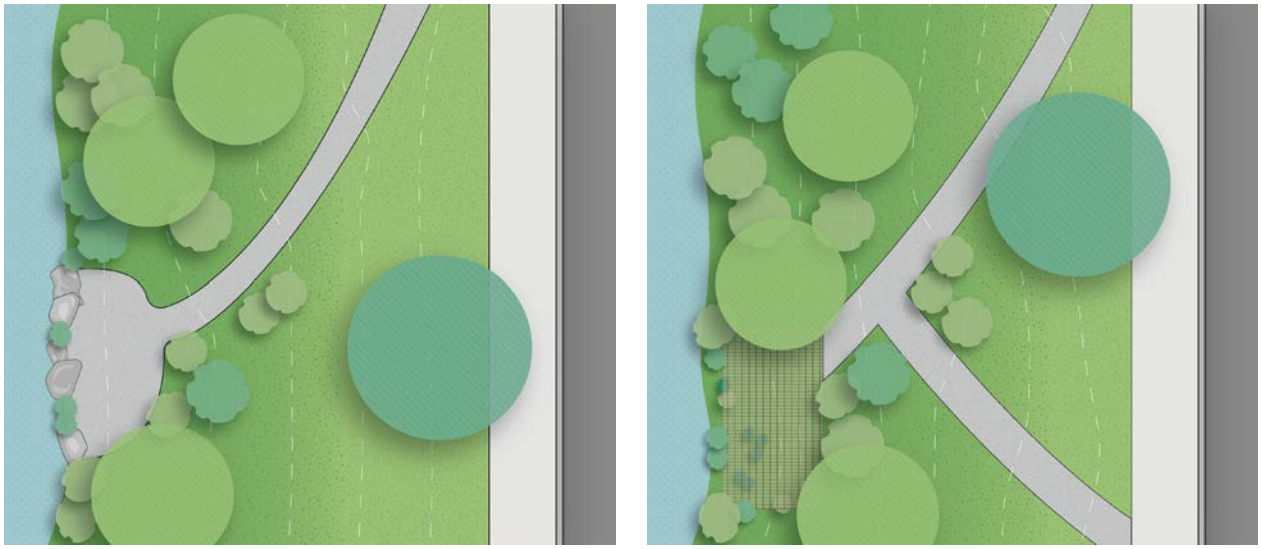


FIGURE 4.11 APPROACH STRATEGIES

Angled approach paths provide better accessibility on steep slopes and more protection against erosion. Line of sight is maintained for people, but obstructed for undesirable wildlife.

Woodland Access

Currently, the large wooded area in the southwest corner of the park has no established pathways. It is not perceived as a part of the park, but rather, as just a part of the periphery. This is a lost opportunity for visitors to interact with a woodland environment within a larger urban context. It can also provide a place for people to stroll in the shade on hot days, a respite for both people and wildlife.

The lack of regular visitor traffic to the woodland contributes to the occurrence of illegal activities, such as dumping of trash and late-night gatherings. A more regular pedestrian presence would provide eyes and ears during daylight hours, and if regularly maintained, would generally signal to people that the area is cared for, and is not a place for illicit activities.

It is recommended that an ADA-compliant pathway be provided in the woodland. A meandering pathway will provide the most interest, taking advantage of gentle slopes and existing mature trees to keep the pathway interesting. To maintain safety, keep understory planting relatively low, except where it may be desirable to block neighboring views. Focus any ornamental plantings along the trail to limit the amount of maintenance needed.

FIGURE 4.12 CONCEPTUAL PLAN FOR THE WOODLAND ACCESS TRAIL
A woodland path would create a unique experience of the park and provide informal monitoring of the area, deterring illegal dumping and the unchecked spread of invasive species.

INLETS AND OUTLET IMPROVEMENTS

The four inlets at the pond carry water from the surrounding lawns, streets, sidewalks, parking lots and roofs and deposit that water into the pond during rain or snowmelt events. The water is laden with sediment, debris, and pollutants. Since this water originates beyond the park property, a range of different strategies are needed to tackle the problem of water quality at the pond's inlets.

Some interventions can be implemented on park property to treat the water at the end of the inlet drain pipes. These strategies are likely more achievable because they are within the control of the BPRD, and can be implemented in the short term if funding allows. Other 'upstream' interventions could improve water quality in the pond, but will require coordination and collaboration with other agencies, municipalities, private entities and individual homeowners. It is more efficient to treat the water 'upstream' of the pond rather than at the 'end of the pipe', but given jurisdictional and ownership challenges, both are discussed.

Interventions in the Sewershed

Stormwater runoff from streets, sidewalks, and lawns generally enters the inlets by traveling over land to a catch basin, and then through a series of pipes, eventually being carried to the pond.

Catch Basins

Catch basins can be upgraded to improve water quality by incorporating various features and technologies that enhance their pollutant removal capabilities. Installing filters or inserts within catch basins can help capture and remove pollutants such as sediment, debris, oil, and trash from stormwater runoff. These filters or inserts must be regularly emptied to maintain their effectiveness and to ensure that stormwater can continue to flow into storm drains, as needed to avoid localized flooding. Everything caught in the filter is material that doesn't end up in the pond.

Standard catch basins can also be replaced with basins that include a sump, an area at the bottom of the catch basin where solids like trash and sediment can settle out before the water continues on into the piped storm drain system. Because of the construction and expense, this technique is typically only an option when a catch basin is being replaced for another reason. These strategies also require a commitment to regular maintenance to remove and dispose of the accumulated material in the sump.

Adding filters to catch basins or installing catch basins with sumps can significantly reduce the amount of pollutants entering water bodies and help protect water quality. Catch basins are generally under the control of the Boston Water and Sewer Commission.

Education and outreach can also be a component of catch basin improvements. Throughout Boston, many catch basins have signs or plaques that identify that the catch basins drain to the Charles River or to Boston Harbor. Similar signs could be installed in the local neighborhood to identify storm drains that take water to Chandler Pond. This could help to raise awareness among the public about the importance of not dumping illicit materials into the storm drains and the role of catch basins in the pond's health.

Intercepting Runoff

Stormwater can also be treated before reaching the catch basin by redirecting runoff to vegetated swales or biofiltration cells, allowing natural vegetation to filter out pollutants. This option is a type of green infrastructure solution to enhance pollutant removal and promote infiltration.

Converting paved surfaces in the sewershed to pervious pavements can reduce the volume of runoff reaching the catch basins by allowing stormwater to infiltrate into the ground and be naturally filtered. New construction of low-traffic, residential or light commercial parking lots are a great opportunity to pursue installation of impervious pavement. Replacement of traditional pavement is often more difficult to justify economically, but new construction projects are more commonly using pervious pavements.

Interventions at the End of the Pipe

Improvements at the inlet pipes that bring water into the pond are another option. These interventions would occur completely on park property, simplifying the design and implementation process.

Some potential improvements are discussed below. Water quality testing is recommended to ensure that the approaches will target the pollutants of greatest concern.

Installing grate filters or debris screens on stormwater inlets can prevent large debris, trash, and some pollutants from entering the pond. Grate filters are designed to trap and retain solid materials while allowing water to flow freely.

A sediment basin can be constructed near the end of the inlet pipe to capture and settle out sediments carried by runoff. This helps prevent sedimentation and siltation in the pond, which can negatively impact water quality and aquatic habitats, and can decrease the water depth in the pond.

While sediment basins are primarily aimed at intercepting sediment and pollutants that cling to soil particles, bioretention basins can filter and treat the runoff. Bioretention basins are similar to rain gardens, in that they are both landscaped depressions that use vegetation to filter and treat runoff before it enters a water body. However, rain gardens are intended to fully drain of water typically in 48-72 hours, while bioretention basins may remain wet.

Floating wetlands can be placed within the pond near stormwater inlets. These constructed islands support wetland plants that absorb excess nutrients and pollutants, improving water quality.

A Note about Maintenance

Regular maintenance of any of these interventions are essential for their effectiveness. Ongoing inspection, cleaning, and removal of accumulated debris and sediment from interception techniques, catch basins, inlets and their associated structures keeps the system working effectively and avoids localized flooding. Frequency of maintenance depends on the sediment loads coming from upstream and the frequency of severe storms. For the first year or so, it is valuable to monitor the systems at least monthly and after any major storms, to help establish the triggers and frequency with which subsequent monitoring should occur.

Outlet

The pond's outlet structure helps regulate water levels, prevent flooding, maintain water quality, and ensure the overall health of the pond and its surroundings.

A maintenance plan should be established to ensure that the outlet structure remains effective over time. Regular inspections and cleaning can help prevent clogs, debris buildup, and other issues.

PLANNING FOR CLIMATE CHANGE

Climate change is likely to bring a number of new challenges to Chandler Pond and Gallagher Park. Altered precipitation patterns are expected to include increased intensity and frequency of rainfall and extended periods of drought. Given the storm system inputs into the pond, the changing rain and snowfall patterns will likely lead to an alteration of the pond's hydrology - its water level, inflow and outflow. More frequent and intense storms will create a more variable water level, stressing shoreline vegetation and increasing the risk of erosion.

Rising temperatures can increase the water lost to evaporation and affect the pond's water temperature, impacting aquatic life and water quality. Rising temperatures are also a challenge for park visitors, as they will rely more on the shade and natural cooling provided by vegetation, particularly in the summer months. As shifts in temperature alter plant emergence, bloom times, and dormancy period, native plants could end up out of sync with local pollinators.

The rapid pace of climate change may exceed the ability of many plant and animal species to adapt in place or to shift to more suitable habitats. Habitat conservation will be increasingly important to maintain biodiversity.

A warming climate could also bring new threats to plants and wildlife, such as destructive insects, fungus or diseases.

As climate change affects plant populations, it will also influence the establishment and spread of invasive species. This includes species that are currently present, as well as new species that may arrive in Massachusetts as conditions become more suitable.

Interventions/Adaptation Strategies

Invasive Species

Invasive species and climate change effects could be additive, magnifying the negative impacts. It is likely that the same traits that make invasive species so successful at becoming established will also help them adapt to climate change. Their tolerance to a range of environmental conditions, their ability to compete for resources, their high seed/reproductive rates, and quick maturity will likely mean they will benefit from the disruption that climate change brings.

In addition to human transport of invasive species, extreme weather events or changing air circulation patterns due to climate change could permit the dispersal of new invasive species to the area through seeds, larvae and small animals. Invasive species may expand or shift their ranges north into Massachusetts as the climate warms. If they spread faster than native species, the invasives will be at a competitive advantage.

Research at the University of Massachusetts Amherst has resulted in a list of high-impact invasive vegetation[1]. Researchers evaluated the potential impacts of 100 invasive plants that could become established now, or by 2050 in the states of New York, Massachusetts, Connecticut, or Rhode Island, looking at ecological, economic, human health and agricultural impacts. In total, 20 species were categorized as high-impact, and were further refined by whether their impacts affect Northeast U.S. ecosystems, in particular.

The five species likely to be of greatest concern in the Northeast are:

Anthriscus caucalis, Burr Chervil

Arundo donax, Giant Reed

Avena barbata, Slender Wild Oat

Ludwigia grandiflora, Water Primrose

Rubus ulmifolius, Elmleaf Blackberry

While the potential risk from these plants may be substantial, it is also an opportunity to be proactive in invasive vegetation management and prevent infestations before they can get a foothold in natural areas.

Climate-Responsive Vegetation

Creating a resilient landscape means looking at the pool of replacement vegetation with an eye to climate change. Consideration has been given to plants that are adaptable, heat-tolerant, and drought tolerant, as possible. The

1 Rockwell-Postel, M., Laginhas, B.B. & Bradley, B.A. Supporting proactive management in the context of climate change: prioritizing range-shifting invasive plants based on impact. Biol Invasions 22, 2371–2383 (2020). https://doi.org/10.1007/s10530-020-02261-1

re-vegetation lists also include some species that traditionally have been considered native in areas just south of Massachusetts. Given the potential dangers of introducing species to new habitats, consideration was given to plants in neighboring locations that are non-aggressive in their native ranges, rather than turning to species from Europe or Asia.

This is particularly important with trees, which have long life spans. Climatic changes are likely to push the Boston area outside of the range of some of its traditional native species within the next 50 years.

The idea is to ensure that the park's vegetation is climatically adapted for the future, and can continue to provide ecosystem services including supporting wildlife and biodiversity, preventing erosion, taking up carbon, providing shade and infiltrating and filtering water.

Shoreline Stabilization

More intense storms and fluctuating water levels from hurricanes or severe storms could accelerate shoreline degradation through erosion and create challenges for maintaining stable access points.

Climate change can also influence the growth patterns and health of shoreline vegetation. Changes in temperature and precipitation may affect the distribution of plant species, potentially impacting the effectiveness of vegetation in stabilizing shorelines.

Cooling

Vegetation, especially trees, can significantly mitigate heat stress, both on land and along the shallow edges of the pond by providing canopied spaces. While trees provide shade and reduce heat island effects, they also sequester carbon dioxide, contributing to climate change mitigation.

The master plan advocates planting a variety of plants in the re-vegetation efforts, and grouping those plants into useful buffer areas. Trees and vegetation (shrubs, and tall perennials and grasses) lower surface and air temperatures by providing shade and cooling through evapotranspiration - releasing water vapor through their leaves and allowing rainfall to evaporate from their leaves. Forested areas within urban centers generally have air temperatures a few degrees lower than surrounding areas.

Flooding

Long-term or severe flooding is not expected to be a major concern in the pond. Water exiting the outlet structure remains channelized underground as it makes its way to the Charles River via the Faneuil Brook culvert.

At current estimates of future sea level rise and rainfall totals, the Charles River Dam and locks are expected to protect the Faneuil Brook culvert from being inundated with water and causing any severe flooding in Chandler Pond. However, failures at the Charles River Dam, or obstructions at the outlet at Chandler Pond could result in flooding at the Pond. Most of the slopes at Chandler Pond are steep, and would help to contain any flooding, but gently sloping areas along the shoreline would be vulnerable.

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IMPLEMENTATION & COSTS

SUMMARY

This chapter covers an overview of costs for full implementation of the master plan, and a proposed collection of interventions that are suggested under Phase 1 of implementation of the plan. The estimate for the full build-out is included in the Appendix.

When assessing costs for implementing the master plan for Chandler Pond Park, it is important to factor in not only the initial construction expenses but also the ongoing operating funds required for maintenance and other routine activities. These may include tasks such as mowing, repairs, on-going invasive species management, cleaning inlets or other stormwater features and trash collection, all of which contribute to the long-term upkeep of the park's facilities and amenities.

The proportion of funding to allocate to operations and maintenance can vary significantly depending on factors such as the size of the park, the types of amenities provided, the resiliency of the materials used, and the level of service expected. However, it is common for a substantial portion of a parks department's budget to be spent on operations and maintenance to ensure its ongoing upkeep and functionality.

It's important for park agencies to carefully balance their budgets to ensure adequate funding for both operations and maintenance and capital improvements to meet the needs of park visitors and maintain the quality of park facilities and amenities. Failure to allocate sufficient resources to operations and maintenance can lead to deteriorating park conditions and reduced service levels over time, impacting the overall visitor experience and community satisfaction.

A number of caveats are important to consider. The size of the project means that implementation will be phased, as funding and resources allow. This uncertain timeline creates uncertainty in costs. Material and labor costs can increase rapidly as supply chain shortages, inflation, unemployment, and labor rates fluctuate over time. In addition, given the aggressive nature of invasive species, some areas of the park and shoreline are likely to get worse before the funds are available to address those issues, resulting in an escalation of costs to treat those areas.

Finally, given that BPRD's in-house maintenance is generally limited to mowing lawns, removing leaves in the fall, clearing snow in the winter, and emptying trash barrels, the contractor scope may include up to three years of monitoring the restoration work. For the contractors who bid on the project, there is variability in the success of new plantings and difficulty in knowing precisely how many treatments it will take to eradicate an area of invasive plants. This creates a level of uncertainty in terms of how much work they will be expected to do, as compared to a project where the task is to simply pave a new path. As a result, contractors are likely to price their services at a high rate to ensure they can still make a profit on the work.

PHASING AND PRIORITIES

Given the cost and extent of work involved to fully implement all of the recommendations, it is advisable to move forward with the project in a phased approach. Implementing the master plan in phases allows for a more strategic, efficient, and manageable approach to park improvements, ensuring that limited resources are allocated effectively.

Overall Strategy

While it is difficult to parse the project into distinct phases without knowing the future funding resources, a general strategy can be used to identify priorities. Comparing any proposed work against this strategy can help determine the order in which components should be implemented.

The overall strategy for implementing the master plan is summarized in Figure 5.1. Organizing the implementation strategy into major action areas will help stakeholders effectively allocate resources, prioritize actions, and track progress. This approach aims to be a balanced and holistic approach to park improvements that addresses immediate needs, enhances ecological and visitor experiences, and aligns with the long-term vision outlined in this master plan. A description of each action category of the strategy follows.

Stabilize:

Stabilization actions focus on addressing urgent issues, potential hazards, and the most degraded areas. The goal is to keep those areas from getting worse and to remedy any hazardous situations. Components of the master plan that fall under this strategy include repairing areas of severely eroded shoreline, removing dense stands of aggressive invasive vegetation, and removing or pruning trees that are a safety concern.

Intervene:

Intervention involves targeted actions to mitigate ongoing challenges or stop threats before they can severely affect the park's ecological health, visitor experience, or functionality. The goal is to keep small and medium problems from becoming much larger problems. Components of the master plan that fall under this strategy include stopping small pockets of invasive vegetation from expanding, directing visitors to reinforced access points to stop further erosion, re-vegetating steep slopes, and the installation of shoreline buffer where none currently exists.
Intervention also includes work that lays the foundation for subsequent phases or provides essential infrastructure for the overall project.

Improve:

Improvement activities are enhancements to existing park features to elevate the overall quality of the park's ecology and the visitor experience. Components of the master plan that fall under this strategy include extending existing good quality buffer, low-cost actions that improve water quality at the inlets or in the sewershed, managing access for maintenance, upgrading paths and seating for inclusivity, expanding biodiversity, and improving views.

Add:

Additions focus on introducing new elements or features that align with the park's master plan vision and contribute to its long-term sustainability and vitality. The goal is to create additional value in the park. Components of the master plan that fall under this strategy include developing a pathway through the woodland area, larger stormwater treatment interventions, and developing new or more specific habitats aimed at certain flora or fauna.

Additional Considerations

When planning for future phasing, there are some challenges and opportunities that may cause a temporary shift in priorities, either delaying certain activities or accelerating their implementation.

There may be opportunities to dovetail work with other infrastructure or construction projects happening within the sewershed. For example, roadway repaving or catch basin replacement could be an opportunity to advocate for catch basin improvements in those areas where stormwater drains into Chandler Pond.

Consider the timeline for implementing different components, based on factors such as regulatory approvals and technical challenges. Some components may take more time and effort due to permitting or regulatory requirements.

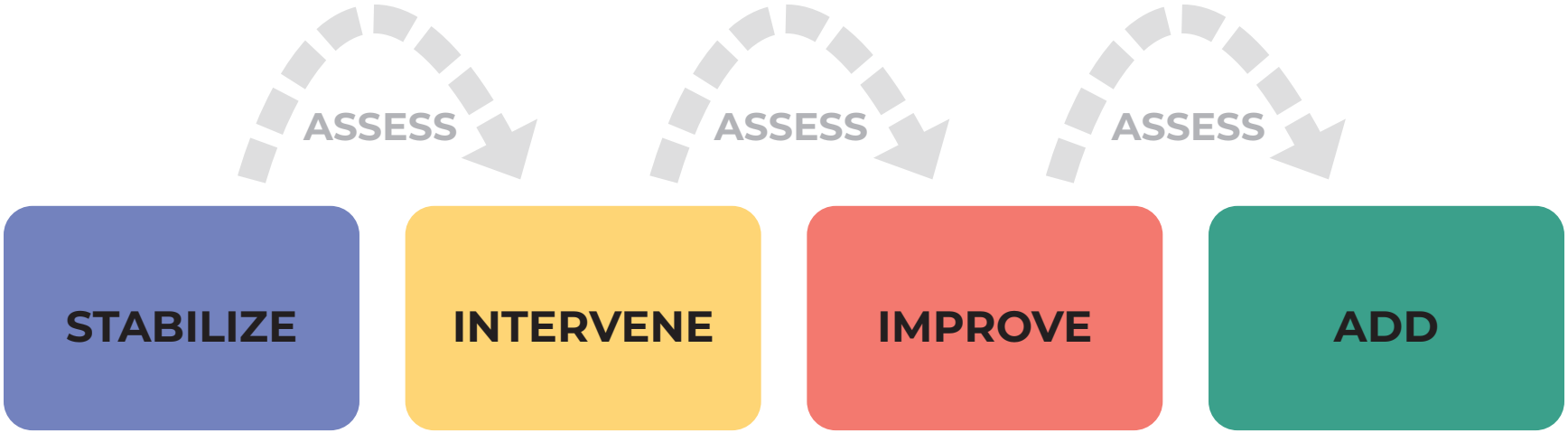

FIGURE 5.1 OVERALL STRATEGY FOR IMPLEMENTING THE MASTER PLAN RECOMMENDATIONS

Four stages in the overall strategy for implementing the master plan, along with examples of recommendations that fall under each strategy. Overall, work at the park would proceed from left to right, with assessment at each phase.

Evaluate whether the changes can be supported long-term. For example, ensure that available funds are sufficient to not only implement invasive removal, but also to monitor that area for a period of time. Spend funds on components of work that can continue to be realistically supported within the available budget and timeline.

Heavily-used areas of the park should be a higher priority than areas of the park that are difficult to access or that have on-going encroachment issues. Also consider the equitable distribution of benefits across different communities and user groups. Prioritize projects that have a positive impact on under-served populations or address existing disparities.

Include education and outreach as a component of all activities. Communicating the strategy and planned projects transparently and clearly to the public, municipal agencies and current and potential funders will help build support and momentum for later phases. It is also a way to check in with the community to ensure the project goals and overall implementation plan still resonates with their expectations and concerns.

Continued Assessment

Relying on a strategy that is less prescriptive increases the importance of regular assessment and evaluation. It also permits maximum flexibility. Circumstances will change over time, and this method of prioritization is adaptable to unforeseen challenges and opportunities. For example, the addition of a new funding partner with an interest in green infrastructure and the arrival of a new and threatening invasive species can both be accommodated within the strategy.

Assessment also means looking at the potential impacts and benefits of each phase of work on the project's overall success. Positive impacts could include enhanced ecological health, increased community engagement or an enhanced experience for visitors. Negative impacts could include the environmental disruption of construction, increased maintenance demands or conflicts between different park users. Projects with high positive outcomes can prove to funders that there is support and momentum for later phases. Some project components may be put aside if other components prove to address critical issues better or provide a better visitor experience.

By applying a well-thought-out prioritization strategy, the implementation of the master plan can be a strategic process that efficiently uses the available funds. It allows resources to be focused on the most critical and impactful components while remaining flexible enough to respond to new developments, and creates an overall roadmap for the master plan's gradual and successful realization.

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PHASE 1

Proposed work in Phase 1 includes addressing the most degraded and heavily-used areas and the areas that could become severely degraded in the short-term if no action is taken. It also includes actions that are needed to lay the groundwork for future phases. Phase 1 does not include work in areas with ongoing encroachment issues or work at the inlets, since water quality testing is pending.

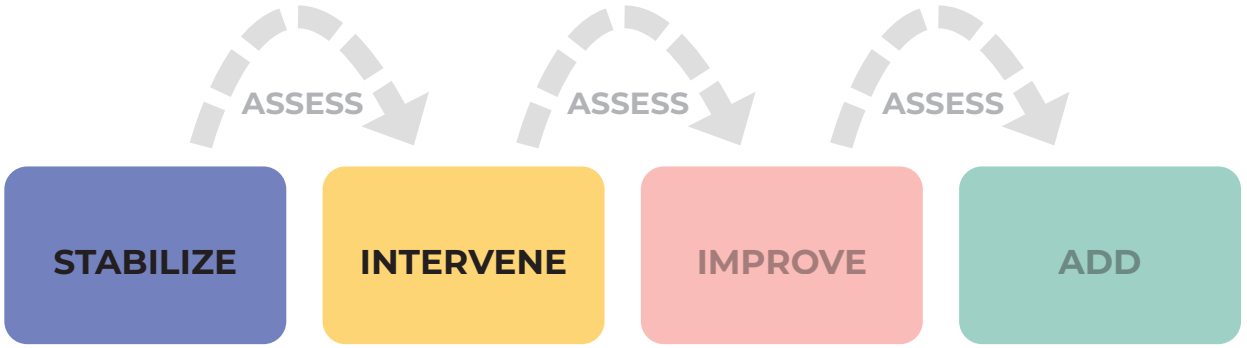


FIGURE 5.2 PROPOSED PHASE 1 WORK FALLS UNDER THE 'STABILIZE' AND 'INTERVENE' STRATEGIES

Key pieces of work proposed for Phase 1 include:

- Removal of isolated colonies of particularly aggressive invasive species (Knotweed)
- Improve the existing buffer in areas of substantial erosion and high traffic, removing invasives and planting native and climate-adapted species
- Repair eroded banks and add vegetated buffer where none currently exists, focusing on steep slopes with high foot traffic and easy access
- Restore compacted soils on steep slopes where foot traffic has impacted the soil's ability to infiltrate water.
- Gain back ground lost to invasive species in areas of recent planting/ improvements
- Construct fencing to protect new vegetation and support its establishment
- Optionally, start thinning large populations of invasive trees and invasive species that will require multiple years of treatment

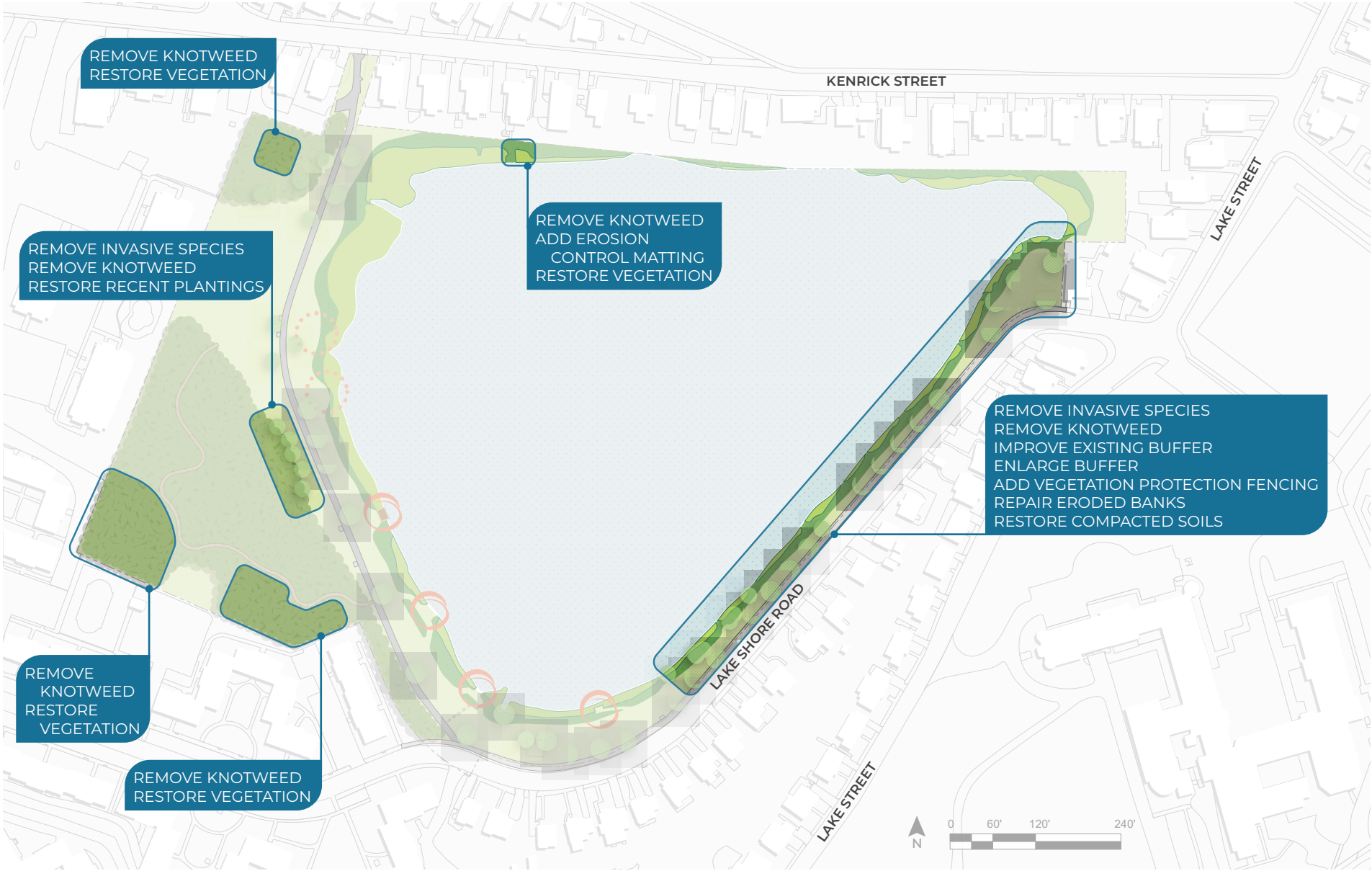


FIGURE 5.3 MAJOR COMPONENTS OF WORK PROPOSED FOR PHASE 1 EFFORTS

FUNDING AND FINANCING MECHANISMS

Successfully implementing the proposed improvements in this master plan, and sustaining them, will require expenditures for both capital projects and maintenance.

Capital projects are large-scale initiatives often targeting infrastructure improvements, facility upgrades or land acquisition. For the master plan, capital projects would include construction of the access points, improvements to the inlet pipes, large-scale removal of invasives species, installation of signage, or construction of the woodland trail.

It is common for capital projects to have multiple phases that each have design, permitting, construction and monitoring stages. Capital expenses are generally covered through an allocation of city capital funds, Community Preservation Act funding, or grants (See Figure 5.4). All of these sources are competitive, and many sources of capital funding are allocated months or years in advance. Capital project funds are typically tied to a specific project, may only be available for a limited time, and are separate from the day-to-day operating budget.

In contrast to capital projects funding, maintenance or operations funding covers the routine and day-to-day expenses required to operate the park, including things like mowing, cleaning, minor repairs, regular tree pruning, and trash collection.

Some site maintenance, such as mowing, can be handled by BPRD operations staff. More specialized work such as chemical treatment for invasive species can be completed under a separate contracted service. Boston's Urban Wilds Program manages the city's urban wilds - permanently protected, undeveloped areas that contain fragments of once larger natural systems. While Chandler Pond is not within the urban wilds property portfolio, urban wilds staff can provide limited support.

Volunteers can also play a role in maintenance activities at Chandler Pond, but supervision and oversight are important components to ensure resource protection. In-kind contributions of products and services, including volunteer help, can also be a boost for a fundraising request for capital funds because it shows widespread commitment to the project.

Capital budgets allocate funds for design, construction, and site improvements. Operating or maintenance budgets address the ongoing operational needs of the park. Both funding sources must be in place to ensure effective management and maintenance of the improvements at Chandler Pond.

See the Appendix for information on costs - the capital funds needed to implement the master plan as well as a discussion of the ongoing land management costs required to maintain the park improvements.

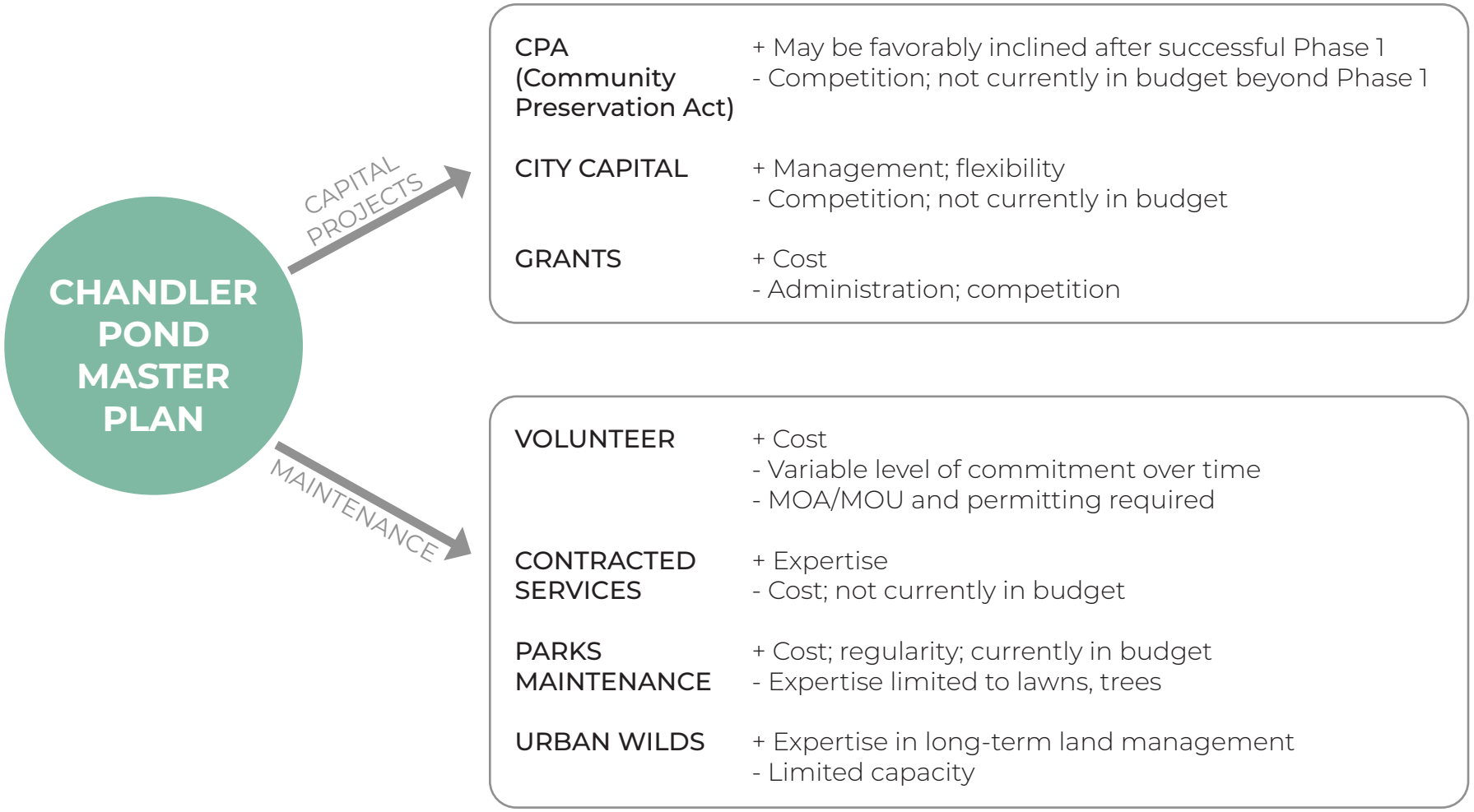


FIGURE 5.4 POTENTIAL RESOURCES AND FUNDING SOURCES FOR WORK AT CHANDLER POND
The master plan requires both capital funding for construction activities and funding dedicated to maintenance and management.

MAINTENANCE AND ADAPTIVE MANAGEMENT

While design interventions and physical improvements are a large part of the master plan, it is also imperative that park features be effectively maintained and managed to ensure long-term functionality, safety, and aesthetic appeal. This chapter reviews some of the major considerations of park operations and maintenance.

According to data from the National Recreation and Park Association (NRPA), park agencies in large jurisdictions typically allocate an average of around 55% of their total operating budget to managing and maintaining parks and open spaces[1]. This includes expenses such as salaries for park staff, landscape work, maintenance of facilities and amenities, supplies, and contracted services.

DESIGN AND CONSTRUCTION CONSIDERATIONS

Given the significant expenditures in maintenance made over the life of a park, it is important to consider how design and construction can impact the future maintenance and operations demands of Chandler Pond Park. Some key factors to consider as implementation of the master plan proceeds:

- Choose materials for pathways, signage, seating, fencing, and other amenities that prioritize durability, safety and longevity.
- Ensure maintenance vehicles and personnel can access the locations they need. Maintain pathways widths that accommodate the use of the proper maintenance equipment.
- Provide appropriate signage for park rules, water safety, wildlife awareness, and discouraging support of nuisance wildlife.
- Ensure that access points and paths are constructed to be safe and accessible to all visitors, including those with disabilities.
- Use signage to guide visitors to established access points.
- Ensure adequate stormwater infrastructure is in place to manage and treat water flows from within the park, when additional walkways are added.
- Utilize primarily native plants. Supplement native plantings with near-native plants that are adaptable, heat-tolerant, and drought tolerant.
- For ease of vegetation maintenance, group like with like. Keep trees and shrubs, which only require intermittent pruning, together. Establish low, grassy vegetation in large swaths that are clearly delineated from turf areas to make semi-annual mowing easier.
- Protect newly treated and replanted areas with vegetation protection fencing, until plants are established - approximately 3 years.
- Consider reducing the amount of area devoted to lawn, and transitioning to low-maintenance native herbaceous areas.

Well-designed, accessible pathways and amenities require less maintenance as they are easier to clean, repair, and maintain. Poor layout and material choices can lead to erosion, congestion, accessibility barriers, or safety hazards. High-quality materials and durable infrastructure and amenities can reduce the likelihood of premature wear, minimizing the need for frequent repairs and replacements. This lowers long-term maintenance costs.

1 National Recreation and Park Association. 2023 NRPA Agency Performance Review. Retrieved from: https://www.nrpa.org/publications-research/research-papers/agency-performance-review/

Native plant communities often require less water, fertilizer, and pesticide use, leading to lower ongoing maintenance costs. Additionally, native plants generally have a higher rate of establishment in their native habitat when compared to non-native plants.

OPERATIONS AND MAINTENANCE CONSIDERATIONS

Effective maintenance planning and management strategies, including regular inspections, preventive maintenance programs, and community engagement efforts, are also essential for preserving the park's quality and usability over time. Operational and maintenance considerations ensure the safety of visitors, the health of the ecosystem, and the overall quality of the park experience. Here are some key factors to address:

- Monthly, spring through fall, monitor water quality parameters such as dissolved oxygen, pH, and nutrient levels.
- Regularly monitor for new and returning invasive species in the park (See section later in this chapter). Early detection, rapid response, and control measures are crucial to prevent and mitigate the negative impacts of invasive plant species.
- Manage vegetation near access points twice per year, to ensure visitors can use these locations, reducing the likely of people making their own paths through the wetland or along the shoreline.
- Review erosion control measures twice per year. Repair eroded areas promptly to prevent sediment runoff and restore the stability of the shoreline.
- Inspect and clean infrastructure at least twice per year to maintain proper function. This includes inlets, outlets and access points.
- Ensure that access points and paths are free of obstacles and that pathways continue to be safe and accessible to all visitors, including those with disabilities.

The Role of Volunteers

Volunteers can make important contributions as stewards of Chandler Pond and the surrounding park. Local residents and regular park users are well-positioned to notice and report dumping, either of yard waste or trash, and encroachment issues to 311. Volunteers should also be encouraged to report any inlet or outlet issues to ensure those pieces of infrastructure receive the attention they need, as well as the return of invasive species, unauthorized tree removal, tree limbs downed by storms, or other damage to the park.

Volunteers who would like to participate in hands-on activities to benefit the park, such as litter pickup or select removal of invasive plants, may only do so with advance coordination and authorization from BPRD. Volunteers who will be removing invasive vegetation must first be trained and then supervised by BPRD staff. Volunteers should be trained to identify both the invasive species and any native species that might be close in appearance to the targeted invasive species. For example, young alder trees have leaves that could be mistaken for invasive buckthorn. Proper removal and disposal techniques are key to ensuring that roots are completely removed, seeds are not spread through removal, and soil disturbance of native species is minimized.

Some invasive species will need to be bagged and disposed of off-site to prevent their re-establishment. Some invasive species that supervised volunteers can successfully address include garlic mustard and oriental bittersweet, for example. More on the use of volunteers in tackling invasive species is included in the Appendix in "Table A.1 Invasive Species Treatment" on page 83.

Maintenance Schedules

Figures 6.1 through 6.3 lay out a proposed maintenance schedule for each of the major areas of the park - the shoreline and buffer, the lawn and pathways, and the woodland. Tasks are shown as regularly-scheduled activities, or as activities where monitoring will determine how often the task is necessary.

A suggested responsible party is also included. Responsible parties include Boston Parks and Recreation Department, which includes Parks maintenance as well as Urban Wilds staff, Contracted Maintenance, which means that BPRD would contract with an outside provider to complete a task, or volunteers, which could be the Friends of Chandler Pond or some other group.

While some tasks may have more than one entity involved, the chart displays the entity that is expected to contribute the most manpower or resources.

WATER QUALITY TESTING

Water quality data will help stakeholders make more informed decisions about how best to put limited funds to use in improving water quality. This is particularly important for identifying interventions that can help with stormwater flowing into the pond from its four inlets. Since the land outside of the park boundaries is controlled by numerous individuals, organization and businesses, a combination of management, education, and collaboration are likely going to be needed to effectively manage water inputs to the pond.

When considering water quality testing, work with stakeholders to decide on the goals for water quality testing. Testing locations, frequency and seasonality will be different depending on what information is sought. If ensuring that the pond is safe for recreational activities such as swimming, fishing, and boating, testing might include bacteria levels to help identify health risks. If the priority is to ensure the pond conditions support aquatic life, testing could instead focus on dissolved oxygen and temperature. If algal blooms are a problem, water quality testing might focus on nutrient levels. Water testing agencies will be able to suggest a water quality testing regimen that can meet the testing goals.

Water quality testing should also investigate individual sources, if possible. Each inlet pipe that brings water to the pond should be tested to determine which pipe brings the greatest, or most concerning, pollution loads. Once pollutants are identified, work can begin to tackle the sources, whether it is fertilized lawns, animal waste, soil erosion, road salt, or construction runoff, for example.

Education, outreach, and partnerships with major landowners and other city departments may be needed to significantly change the pollutants entering the pond through its inlets. At least basic testing should continue to be done every year to identify problems early and allow prompt action to be taken in the case of new or increasing pollutant levels.

Basic parameters for understanding water quality typically include:

pH - measures the acidity or alkalinity of the water.

Dissolved Oxygen - measures the amount of oxygen available to fish and other aquatic organisms.

Nutrients - measures common nutrients like nitrogen and phosphorus. High levels can cause algal blooms and reduce water quality.

Turbidity - measures the clarity of the water by looking at the amount of suspended particles in it.

INVASIVE SPECIES

Complete versus Functional Eradication

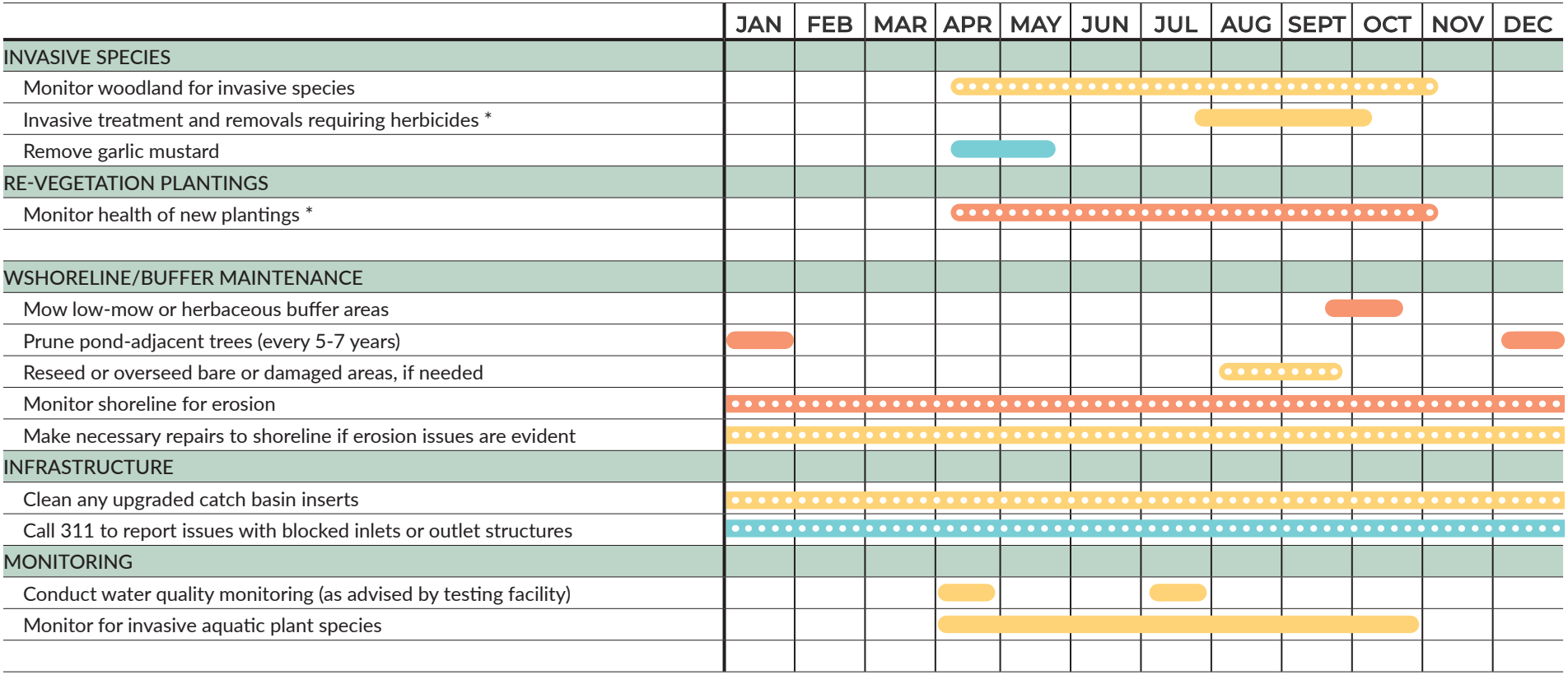
Ideally, there would be no invasive species in the park or the pond. Complete eradication, however, is expensive, difficult, and requires an extremely high level of vigilance.

Eradication requires removing all existing plants and continuing to monitor the site for as long as seeds remain viable. Eradication is easiest when there are few plants and those plants are removed before flowering and setting seed. Seeds or pieces of vegetation can still move into the site from wildlife or even on visitors' shoes, however, so complete eradication never truly ends. Once a species is present in large numbers, or in multiple locations, the resources needed to achieve complete eradication are substantial.

At Chandler Pond, there are at least 13 terrestrial invasive species that have been identified. Achieving complete eradication of all 13 species everywhere on the property may not the best use of resources.

Functional eradication changes the focus from completely removing invasive species to limiting their numbers below the level that interferes with the ecological or recreational goals. This approach frees up resources for other benefits, such as expanding accessibility, improving the wooded area or developing additional access points that might provide greater benefits to wildlife and human visitors

Maintenance Schedule for Shoreline/Buffer



* = Include in construction contract for 3 years

Scheduled Activity

Monitor/Complete Activity as Needed

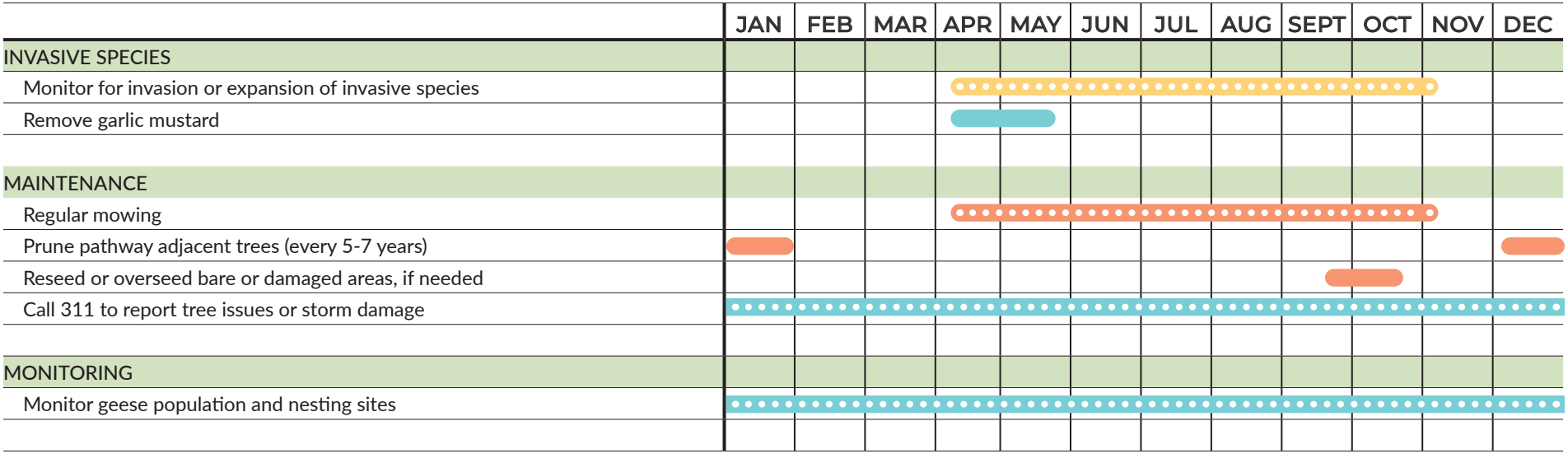
Boston Parks and Recreation Department, including Urban Wilds Program

Contracted Maintenance

Volunteers, with proper training and supervision

FIGURE 6.1 MAINTENANCE SCHEDULE FOR THE SHORELINE AND BUFFER AREAS AROUND CHANDLER POND

Maintenance Schedule for Lawn and Pathway Areas

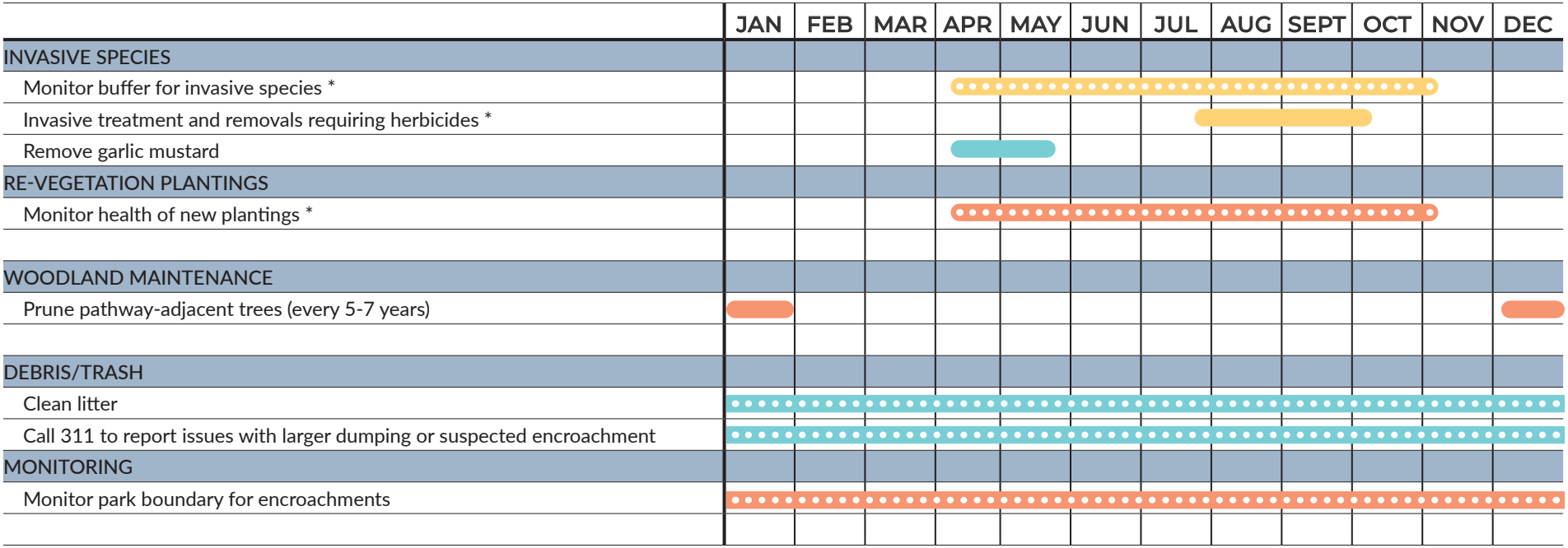


* = Include in construction contract for 3 years

Scheduled Activity
Monitor/Complete Activity as Needed
Boston Parks and Recreation Department, including Urban Wilds Program
Contracted Maintenance
Volunteers, with proper training and supervision

FIGURE 6.2 MAINTENANCE SCHEDULE FOR THE LAWN AND PATHWAYS IN CHANDLER POND PARK

Maintenance Schedule for Woodland



* = Include in construction contract for 3 years

Scheduled Activity
Monitor/Complete Activity as Needed
Boston Parks and Recreation Department, including Urban Wilds Program
Contracted Maintenance
Volunteers, with proper training and supervision

FIGURE 6.3 MAINTENANCE SCHEDULE FOR THE WOODLAND AREAS IN CHANDLER POND PARK

than eradicating every single instance of all 13 invasive species.

Total eradication isn't always a realistic, or even a desirable, goal when responding to invasive species infestation. Control is a spectrum, ranging from eradication to containment to suppression. If complete eradication isn't feasible, or isn't feasible in the short term, consider containment.

Containment

If an invasive species has already taken hold of a large area, or multiple areas, containment is the next best strategy. Depending on the size of the area, it could be treated over the course of one growing season, or may require multiple growing seasons. Generally, start at the edges and work inward, keeping watch over the areas that have already been treated to spot any lingering invasives. Property boundaries are particularly susceptible to re-infestation, as abutting property owners may not effectively manage invasive species on their properties.

If containment isn't feasible, or isn't feasible in the short-term, suppression is another strategy for consideration.

Suppression

Suppressing invasives species focuses on limiting their spread and limiting their ability to produce seed. For example, while knotweed spreads by multiple means, simply cutting it a few times during the growing season will keep it from expanding its footprint. All cuttings must be properly disposed of, however, since knotweed can grow new plants from bits of existing vegetation. Deploying the beetle that eats Purple Loosestrife ("Invasive species and their management techniques" on page 82) is another example of suppression.

INVASIVE SPECIES MONITORING PLAN

Vigilance with invasive species monitoring is critical. Seeds can lie dormant in the soil for years, birds and other animals can bring fresh seed or plant pieces in from outside the property, and invasive seeds can also be deposited on the site through the wind, the inlets, and even from visitor's shoes.

Monitoring and Treatment Schedule

A monitoring schedule for invasive plant species should be capable of detecting the presence and spread of invasive plants. The schedule needs to consider the growth and flowering patterns of the target invasive species, as well as the appropriate timing for management actions.

An aggressive monitoring schedule is presented here, but can be modified depending on which species are being targeted, or based on available funding. Ideal times for targeting each terrestrial invasive species currently found in the park is available in "Table A.1 Invasive Species Treatment" on page 83.

Early Spring (March - April):

Start monitoring to detect any early signs of invasive growth. Invasives often leaf-out earlier than native plants, which is part of what helps them become so dominant.

Look for emerging shoots, leaves, and signs of new growth from areas that had known populations of invasive plants.

Early season invasives, such as garlic mustard are a good target for treatment in early spring before they flower and set seed.

Work to minimize areas of bare soils, particularly where re-vegetation efforts have taken place, to prevent invasive seedlings from germinating.

Late Spring (May - June):

Continue monitoring activities since invasive species grow rapidly during this time.

Examine plants when flowering or fruiting to help with identification.

Some prolific seed-producing plant species like garlic mustard should be removed or mowed before they set seed.

Focus monitoring for new invasives on high-risk areas, such as areas with newly disturbed soils or areas with a history of invasive presence.

Summer (July - August):

Monitor for areas of new growth near existing colonies, and note any significant expansion of invasive species.

In summertime, pay attention to areas that receive abundant sunlight, as invasives often thrive in these hot, stressful conditions.

Remove or treat invasives before they set seed.

Some invasives like knotweed can be cut when flowering and treated with herbicide (by a MDAR-licensed professional), which causes the plant to take the herbicide down into its roots.

Early Fall (September - November):

Remove or treat invasives before they set seed.

Continue monitoring as many invasive species remain active until the first frost.

Document any changes in invasive plant coverage and location, which will help get a head start on monitoring in the spring.

Early winter, once the herbaceous plants have died back, is a a good time for winter woody shrub treatment. Wintertime is also an opportunity to plan for the upcoming monitoring season, and to review and analyze data from the previous year's monitoring and removal efforts.

GPS technology can be used to map the location of invasive species, helping to track and share progress over time. However, a low-tech paper record of observations, species, and plant density is also a great way to collect the information, although sharing the info with other stakeholders or municipal authorities may be more difficult.

Regular monitoring is essential to early detection and effective management of invasive plants, preventing them from out-competing native species and disrupting the ecosystem.

Best Practices

- Educate maintenance personnel and volunteers on invasives and native species. Provide images and descriptions of plant species.
- Utilize volunteers to remove young shrubs or vegetation that can be easily pulled by hand. (e.g. garlic mustard, young buckthorn). Volunteer activity must be supervised at all times by BPRD staff. Emphasize proper disposal.
- Enlist professionals to remove species requiring herbicide treatments and larger, more mature species of trees and shrubs.
- Remove seedlings and saplings of invasive trees if soil conditions allow for complete removal of the root. This work can be done even if more mature trees cannot yet be removed. This will prevent the next generation from taking hold.
- Don't mow invasive plants that have gone to seed. Carefully cut and bag for disposal.
- Consult with the Conservation Commission before undertaking work in any wetland area or regulatory Buffer Zone.

Identification

For identifying invasive species common in Massachusetts, there are several reputable resources:

Massachusetts Invasive Plant Advisory Group (MIPAG):

MIPAG (https://www.massnrc.org/mipag/) is a coalition of organizations dedicated to addressing invasive species issues in Massachusetts. Their website includes resources, research, and recommendations for managing invasive plants.

Massachusetts Audubon Society:

Massachusetts Audubon (https://www.massaudubon.org/nature-wildlife/invasive-plants-in-massachusetts) provides resources on invasive species and their impacts on native ecosystems. They offer information, events, and educational programs related to invasive species identification and management.

iNaturalist:

The iNaturalist app and website (www.inaturalist.org) allow you to upload photos of plants and other organisms for identification by a community of experts and enthusiasts. This can be a helpful tool for getting identification assistance.

Native Plant Trust (formerly the New England Wild Flower Society):

www.nativeplanttrust.org offers resources for identifying invasive plants, as well as native plants, in the New England region. They provide educational programs, workshops, and field guides for plant identification.

When using online resources, access information only from reputable organizations and government agencies to ensure accurate identification and guidance.

Laws and Regulations

In Boston, wetlands are regulated under a number of federal, state and local laws. The laws are designed to preserve the ecological and hydrological functions of wetlands and their buffer areas. Some of the key regulations are:

Massachusetts Wetlands Protection Act

The Massachusetts Wetlands Protection Act (WPA) (M.G.L. Chapter 131, Section 40) is a state law that regulates activities in and around wetlands and other water bodies. The Massachusetts Department of Environmental Protection is responsible for administering and enforcing these regulations. A permit is required for activities within 100 feet of a wetland or water body. That 100-foot area is called the Buffer Zone. The regulations prioritize avoiding wetland impacts, but if impacts cannot be avoided, the permit then focuses on minimizing and mitigating impacts. The regulation also requires notice to, and approval from, the local Conservation Commission.

Boston Conservation Commission and the Boston Wetlands Protection Ordinance

The Boston Conservation Commission is responsible for reviewing and permitting projects within wetland and buffer areas within the city of Boston. In 2019, Boston's Wetlands Ordinance went into effect, giving the city greater authority to protect wetlands and waterbodies, including jurisdiction over ponds 5,000 square feet or greater. The Commission has implemented administrative and procedural regulations for the Ordinance, and requires that proposed projects submit a permit application detailing the proposed work, how that work will meet the performance standards in the Ordinance, how stormwater will be managed, and how climate change will impacts the property. In addition, the Conservation Commission may include specific requirements in its permit, such as mitigation or monitoring.

U.S. Army Corps of Engineers (USACE)

Certain wetlands in Massachusetts fall under federal jurisdiction due to their connection to navigable waters. The Clean Water Act, administered by the USACE, regulates the discharge of dredged or fill material into waters of the United States, including wetlands, through a permitting process. The USACE also regulates dredging, excavation and disposal activities under the Rivers and Harbors Act. Dredging activities typically require a permit.

Wetland regulations can be complex. Before undertaking any activities in the wetland or regulatory Buffer Zone of Chandler Pond, consult with the Boston Conservation Commission, the Massachusetts Department of Environmental Protection, and other relevant agencies to ensure compliance.

ADAPTIVE MANAGEMENT

Adaptive management is a flexible and iterative approach to managing natural resources and ecosystems. Work that is implemented, particularly invasive species management, re-vegetation, and water quality interventions (but also regular maintenance activities) should be monitored to evaluate their outcomes. Are certain invasive species recurring more than others? Do some plants do well, while others seem to struggle? Are water quality test results improving?

With changing information, management and maintenance strategies may need to be adjusted. Natural systems are complex, so on-going learning and a refinement of strategies over time is a sign of good management, not a sign of failure.

Similar to the strategy for how phasing decisions are made, adaptive management is a cycle of planning, implementing, monitoring, evaluating and adjusting. Repeat.

APPENDIX

INVASIVE SPECIES AND THEIR MANAGEMENT TECHNIQUES

Invasive Species Management

The goal of invasive vegetation species management at Chandler Pond is to preserve biodiversity, support recreation, and improve ecosystem health.

While invasive species prevention is the ideal, urban sites, particularly those where disturbance has occurred, are highly prone to infestations and prevention is nearly impossible. In these situations, active management is necessary to prevent further ecological damage.

Methods used for the control and management of invasive species can be divided into broad categories of Mechanical Management, Physical Management and Chemical Management.

Mechanical control includes techniques such as mowing, cutting, girdling trees, or other activities using tools or machines. Often, mechanical treatments are used in conjunction with chemical (herbicide) controls, which can increase their efficiency.

Physical, or manual, control involves activities done by hand, such as smothering, soil solarization, hand-pulling, using a weed wrench, utilizing goats or other herbivores, or digging out individual plants. Note that goats are non-selective and will each all vegetation, not just the invasive species.

Chemical control involves the use of herbicides. While herbicides can be very effective, they can also harm desirable vegetation and endanger wildlife is not used appropriately and judiciously by a licensed herbicide applicator. Use of herbicides near water should be carefully managed. Only wetland-approved herbicides should be used around the resource area.

Other management methods include biological control and cultural control. Biological control is the intentional introduction of a species' natural predator to reduce that species' population. The introduction of a new species to an ecosystem must undergo extensive research and testing to ensure that it does not have unintended consequences, but this type of control is in use. For example, the Galerucella beetle has been introduced into areas with invasive purple loosestrife populations. The beetles feed on the leaves and stems of the Purple loosestrife plant, weakening the plants and reducing their ability to compete and reproduce. Biological control is usually not completely effective on its own, but can keep an invasive species in check.

Cultural control refers to changing people's habits or behavior to manage or mitigate the introduction, establishment and spread of invasives. One example could be providing information and raising awareness among the public, neighboring landowners and stakeholders about the risks of invasive species, how to identify them, and the best practices for their prevention and management. Cultural controls can also include promoting responsible landscaping and alternatives to invasive ornamental plants, or even implementing laws that restrict the sale or transportation of certain species. Programs where volunteers are engaged in invasive species monitoring, invasive removal events, or restoration efforts are also a form of cultural control.

The following pages summarize the invasive species identified at Gallagher Park,what makes them a problem, and the mechanical, physical, and chemical control methods recommended for their removal. The table also identifies which activities are appropriate for volunteers, and which activities should only be completed by professionals or those with herbicide applicator licenses.

Note that permitting is required for any vegetation removals that disturb the soil within the 100' buffer of the delineated wetland or the shoreline of the pond.

Species Name				Control and Management Methods			Volunteers/Professionals	
Scientific Name	Common Name	Description	Problem	Mechanical Management (M)	Physical Management (P)	Chemical Management (C)	Appropriate for Volunteers **	Appropriate for Professionals
Acer platanoides	Norway Maple	Deciduous tree with large leaves with 5 sharply pointed lobes. Leaf stems exude a milky sap when cut.	Prolific seed producer, produces compounds toxic to the roots of other plants. Its ability to thrive in both sun and shade means it can develop into dense stands that outcompete natives.		Hand-pull/dig seedlings and sprouts from moist soils any time of year. Use of a weed wrench on saplings can be moderately effective.	Treat cut stumps of mature trees to prevent resprouting. Girdling mature trees, combined with herbicide application, can also be effective. Basal bark application of herbicide can be done with a high concentration applied to the bark in fall or early winter.	P	P, C
Acer pseudoplatanus	Sycamore Maple	Deciduous tree with leathery, coarsely-serrate, 5-lobed leaves. Bark on mature trunks will flake, exposing inner orange bark.	Prolific seed producer. Developed dense stands that shade out and outcompete natives.		Hand-pull/dig seedlings and sprouts from moist soils. Dig up larger plants.	Treat cut stumps of mature trees to prevent resprouting. Girdling mature trees, combined with herbicide application, can also be effective. Basal bark application of herbicide can be done with a high concentration applied to the bark in fall or early winter.	P	P, C
Ailanthus altissima	Tree-of-Heaven	Deciduous, weak-wooded tree with odd-pinnate compound leaves. Smooth pale grey bark.	Seeds dispersed by wind and water. Dense thickets prevent the establishment of native species.		Remove seedling and saplings by hand pulling when soils are moist. Dig up larger saplings. Saplings can have a deep taproot, and all parts of the root must be removed to prevent resprouting.	Do not cut without treatment - this causes vigorous re-sprouting. Cutting, along with the application of herbicide, can kill mature trees. Basal bark application of herbicide is most effective for trees that are 4 to 8 inches in diameter. Apply when tree has fully leafed out, but before it shows fall color.	P	P, C
Alliaria petiolata	Garlic Mustard	Biennial plant, rising 1-3' tall in its second year, producing small white flowers.	Changes the soil conditions around it to be toxic to other plants. A single plant can produce an enormous number of seeds, which are carried by wind, water, and on the shoes/clothing of people who walk through it. Seeds persist in the soil for several years.	Repeated cutting or mowing (done a few inches above the soil after flower stalks elongate, but before flowers open).	Hand-pull small populations, ideally before the plants set seed. Persistent seeds means annual pulling will be needed for 5+ years. Re-seed with native species in areas of suspected seedbanks, to provide competition.	Early season (March/April/May) foliar application of Triclopyr can be used on large stands that are not manageable to remove by hand, or that are on slopes that would be at risk of eroding with large-scale hand-pulling.	M, P	M, P
Celastrus orbiculatus	Oriental/Asiatic Bittersweet	Climbing vine with yellow-orange fruit capsules that split open to reveal a red interior.	Invades field edges and forests, forming a dense mat that smothers existing trees and shrubs. Creates a safety hazard, as the weight of the vines can cause weak-wooded trees to fail.	Can brush mow infestations of small vines if vines are not growing on top of desirable vegetation. This prevents bittersweet from going to seed, but chemical treatments are needed for eradication. Clipping and bagging fruit can help to prevent spread.	Hand-pull young vines or small infestations any time of year, ensuring the entire root system is removed.	Larger vines that have climbed trees should be cut at two points any time of year. Remove as much of the overhead portion as can be reached. Apply herbicide to the cut end of the stump in autumn and early winter. Allow hanging material to decay naturally if it cannot be safely removed.	M, P	M, P, C

TABLE A.1 INVASIVE SPECIES TREATMENT

Table showing the 13 terrestrial invasive species identified at Chandler Pond Park, including their identifying features, control and management methods and whether their management is suitable for volunteers or should be handled by contracted professionals. Note than any invasive species treatment within 100' of the shoreline or delineated wetland falls under the jurisdiction of the Boston Conservation Commission.

Species Name				Control and Management Methods			Volunteers/Professionals	
Scientific Name	Common Name	Description	Problem	Mechanical Management (M)	Physical Management (P)	Chemical Management (C)	Appropriate for Volunteers **	Appropriate for Professionals
Elaeagnus umbellata	Autumn Olive	Deciduous shrub, up to 15' tall, with white flowers in spring and red berries in fall	Invades fields and edges and spreads easily. It can fix its own nitrogen, enabling it to outcompete and displace native species.	Can mow if small resprouts are present. Plants respond to cutting by sending out more shoots, so follow-up is necessary.	Hand-pull/dig seedlings and sprouts from moist soil. Remove saplings with a weed wrench. Cut large plants, and dig out stump if possible.	Mature plants can be cut at the base, followed by application of a systemic herbicide to the cut stump. Herbicide can be applied to cut stems anytime in the growing season, but late growing season (July to September) is most effective. Basal bark application of herbicide can be done with a high concentration applied to the bark in fall or early winter.	P	M, P, C
Fallopia japonica	Knotweed	Perennial, growing up to 10' tall, with heart-shaped leaves and white flowers in later summer/early fall.	Invades a wide variety of habitats, forming dense stands that crowd out other plants. The plants quickly develop an extensive root system, making them resistant to eradication by cutting. Even small pieces of plant material can sprout new colonies. Tenacious.	Cutting/Mowing: To control spread, first cut stems in early June or after the plant has bloomed. Cut the plant repeatedly for the remainder of the growing season, 3-4times per year. This prevents the plant from setting seed, and reduces the ability of the plant to send energy back to its roots.	Removal by pulling can be effective in containing the spread in small/new areas, but all root pieces must be removed. Pulling or repeated cutting can control or eliminate young plants. Install wire mesh at soil level after cutting vegetation flush to the ground. Secure mesh tightly so that it remains attached to the ground surface. Mesh will girdle stems of knotweed.	Treatment with systemic herbicide, injected into freshly cut stems can eradicate a population, but repeated applications over 3-5 years may be required. Treatment is best in August/September when the plant is sending reserves back to the root system. Glyphosate is effective.	- -	M, P, C
Frangula alnus	Glossy Buckthorn	Deciduous shrub or a small tree, up to 20' tall.	Prolific producer of fruits, which are spread primarily by birds. Invades fields, edges, woodlands and wetlands, crowding out desirable plants.	Can mow if small resprouts are present.	Hand-pull/dig seedlings and sprouts. Remove saplings with a weed wrench. Cut large plants, and dig out stump if possible.	For larger plants, cut near the base and apply systemic herbicide to the cut stem.	M, P	M, P, C
Lonicera spp.	Bush Honeysuckles	Perennial woody vines with showy fragrant flowers. Fruits are dark purple or black	Invades fields, edges, and forests, producing leaves earlier than many native species, giving them an advantage. Birds and other wildlife spread the seeds through the attractive fruit.	Mowing is not recommended as it will limit spread, but will stimulate additional growth, creating dense mats.	Hand-pulling can control small or isolated populations. Open areas can be mowed before fruit sets, to limit spread, but will require herbicide to eliminate.	Application of a systemic herbicide to freshly cut stumps in summer and autumn can eliminate a population. Foliar applications in autumn can also be effective.	P	M, P, C
Lythrum salicaria	Purple Loosestrife	Perennial, typically growing 3-5 feet high. Long stalks of purple flowers .	Invades wetlands, and can form dense colonies that exclude native plants. One plant can produce a million seeds - spread by waterfowl and water.	Mowing is not recommended as it will spread plant stems that will resprout.	The Galerucella beetle feeds extensively on purple loosestrife, keeping its growth in check. Individual plants can be pulled by hand. Repeated cutting to deplete the plant's resources can also be effective in preventing it from going to seed, but all plant parts must be removed to prevent resprouting.	Application of an wetland-approved systemic glyphosate herbicide to cut stems will eliminate the plant, but may require multiple applications. Apply after flowering but before seeds form (June to August). In wetlands, Conservation Commission approval is required.	P	P, C

TABLE A.1 INVASIVE SPECIES TREATMENT (CONTINUED)

Species Name				Control and Management Methods			Volunteers/Professionals	
Scientific Name	**Common Name**	**Description**	**Problem**	**Mechanical Management (M)**	**Physical Management (P)**	**Chemical Management (C)**	**Appropriate for Volunteers ****	**Appropriate for Professionals**
Rhamnus cathartica	Common Buckthorn	Deciduous shrub or small tree, growing up to 20'.	Produces a large number of fruits, carried by birds, primarily. Invades primarily fields and field edges, forming dense stands that exclude desirable plants.	Can mow if small resprouts are present. Regular mowing (June and August) can reduce plant size and density.	Hand-pull/dig seedlings and sprouts. Remove saplings with a weed wrench. Cut large plants, and dig out stump if possible.	Herbicide application should occur in the fall or early winter. Large plants require the use of a systemic herbicide to freshly cut stumps.	P	M, P, C
Rosa multiflora	Multiflora Rose	Deciduous thorny shrub with white flowers and red fruit.	Forms dense thickets in a variety of habitats - fields, edges, open wetlands and in canopy openings.	Utilize mower or brush mower when plants are young. Populations out in the open can be mowed 3-6 times per year for several years.	Pulling and repeated cutting can remove small populations.	Large populations in wetlands and woodlands likely require the use of herbicides, applied to fresh-cut stems summer through autumn. Apply herbicide in the late growing season (July to September). Basal bark application of herbicide can be done with a high concentration applied to the bark in fall or early winter.	- -	M, P, C
Robinia pseudoacacia	Black Locust	Deciduous tree with white flowers and deeply furrowed bark when older. Smaller branches may have thorns.	Invades fields, grassy areas and open woodlands. Increases soil nitrogen levels, threatening native plants that are adapted to leaner soils.		Cutting is not effective, as it induces prolific resprouting, even from the tree's roots. Hand pull seedlings that sprouted from fallen seed pods (watch for thorns).	Systemic herbicides applied to freshly cut stumps will work, but there is a strong likelihood of required re-treatment.	- -	P, C

*** = Most volunteer invasive species treatment or removal activities should only be done under the supervision of a Boston Parks and Recreation staff member or other authorized entity. With training, volunteers can conduct activities such as clipping and bagging Asiatic Bittersweet or Glossy Buckthorn fruit, and pulling garlic mustard without direct supervision. Contact the BPRD Urban Wilds Program for more information.*

Notes:

1. Control of species in wetlands and wetland buffer areas is subject to the Massachusetts Wetlands Protection Act. Check with local Conservation Commission before undertaking any removal efforts in delineated or suspected wetland areas.
2. See Management Methods for the timeframe or season when management is most critical.
3. Mechanical removal of invasive species should be avoided on sloped areas when possible to avoid causing or worsening erosion. Where mechanical removal on slopes cannot be avoided, implement erosion control practices before, during, and after mechanical removal activities to minimize soil disturbance and protect sensitive areas.
4. Some 'seedlings' of Robinia pseudoacacia may actually be resprouts from the mother plant. When in doubt, a systemic herbicide application to the cut stems should be used.

TABLE A.1 INVASIVE SPECIES TREATMENT (CONTINUED)

COST ESTIMATE - FULL IMPLEMENTATION

The cost estimate for full implementation includes all of the components of the recommendations chapter, with additional allowances built in to account for the effect of the uncertainty of the timeline.

Key pieces of the cost estimate include:

- Invasive removal around the entire shoreline as well as the wooded areas of the site
- Re-vegetation of all cleared areas with both climate-adapted and native tree, shrub, and herbaceous vegetation.
- Development of an increased shoreline buffer, including restoration of compacted soils
- Construction of seven access points including accessible pathways to the access points
- Creation of a pathways through the wooded area at the southwest corner of the property
- General allowance for the improvement of inlets and outlets to improve water quality, which will be refined with information from water quality testing

The estimate for the full build-out of the master plan does not include any costs associated with resolving encroachment issues, such as litigation, purchase of easements, negotiating use agreements, etc. The estimate also does not include regular maintenance costs, beyond the requirement for the short-term maintenance of areas treated for invasive species and the establishment of new vegetation. Annual maintenance for the upkeep of the park would typically fall under the BPRD operating budget, while the cost estimate covers items related to construction - typically funded through capital funding.

Item	Notes	Quantity	Unit	Unit Cost	Subtotal
Project General					
Construction signage & fencing		3600	lf	$16.00	$57,600.00
Tree protection		1	ls	$30,000.00	$30,000.00
Erosion control (compost sock)		4000	lf	$20.00	$80,000.00
Survey/staking		1	ls	$20,000.00	$20,000.00
		Project General Subtotal			$187,600.00
Demolition/Site Preparation					
Tree pruning, safety & structural		10	days	$3,200.00	$32,000.00
Tree removal total (invasive tree species)		200	ea	$1,250.00	$250,000.00
Invasive treatment and removal in existing buffers (assume <50% invasives)	Monitoring included in Land Management Costs	35500	sf	$6.50	$230,750.00
Invasive treatment and removal in area designated to be buffer	Monitoring included in Land Management Costs	19500	sf	$1.60	$31,200.00
Invasive treatment of knotweed	Monitoring included in Land Management Costs	20000	sf	$3.25	$65,000.00
Invasive treatment and removal in woodland (assume <50% invasives)	Monitoring included in Land Management Costs	99500	sf	$6.50	$646,750.00
Vertical mulching on a grid along Lake Shore Road and Lake Shore Road entrances (existing lawn to remain)		60000	sf	$2.50	$150,000.00
Loosen soil, and topdress with compost (new buffer area)		35300	sf	$2.75	$97,075.00
		Demo/Site Prep Subtotal			$1,502,775.00
Earthwork					
Fine grading alongside pathways	Pathways for access points	200	cy	$20.00	$4,000.00
Clean fill at platforms		80	cy	$45.00	$3,600.00
Loam for seeding areas	assume 6" across new seeded areas	1200	cy	$65.00	$78,000.00
		Earthwork Subtotal			$85,600.00
Buffer and Woodland Planting					
Sapling trees (to replace removals +10% new)	Assumes 60% conservation grade/40% nursery grade	220	ea	$300.00	$66,000.00
Shrubs to replace invasives in buffer (60% shrubs, 5' spacing)	Supplemental buffer - 50% planted; 50% seed	200	ea	$65.00	$13,000.00
Perennials to replace invasives in buffer (40% perennials/grasses, 18"	Supplemental buffer - 50% planted; 50% seed	1450	ea	$20.00	$29,000.00
Shrubs to replace invasives in woodland (70% shrubs, 5' spacing)	67% planted; 33% seed	810	ea	$65.00	$52,650.00
Perennials to replace invasives in woodland (30% perennials, 18" spac	67% planted; 33% seed	3800	ea	$20.00	$76,000.00
Shrubs in new buffer (60% shrubs, 5' spacing)	New buffer - 67% planted; 33% seed	620	ea	$65.00	$40,300.00
Perennials in new buffer (40% perennials, 18" spacing)	New buffer - 67% planted; 33% seed	4500	ea	$20.00	$90,000.00
Shrubs to replace knotweed (70% shrubs, 5' spacing)	Replanted areas - 50% planted; 50% seed	275	ea	$65.00	$17,875.00
Perennials to replace knotweed (30% perennials, 18" spacing)	Replanted areas - 50% planted; 50% seed	1275	ea	$20.00	$25,500.00
Plant Establishment Fence along entire buffer		4000	lf	$12.00	$48,000.00
Turf Seeding		54000	sf	$1.25	$67,500.00
Buffer Seeding		25250	sf	$4.50	$113,625.00
Woodland Seeding		33200	sf	$2.00	$66,400.00
Erosion Control Matting		1200	sy	$10.00	$12,000.00
Perennials to supplement invasive tree removals		750	ea	$15.00	$11,250.00
Bank restoration		800	lf	$68.00	$54,400.00
		Planting Subtotal			$783,500.00
Pathways					
Trail surface - upgraded stonedust or geogrid, 5' width	10" excavation, aggregate, filter fabric, binder/geogrid	1400	lf	$40.00	$56,000.00
Trail surface - stonedust, 5' width		670	lf	$25.00	$16,750.00
		Pathways Subtotal			$72,750.00

Item	Notes	Quantity	Unit	Unit Cost	Subtotal
Site Improvements					
Fiberglass/Wooden platform (8x12)		2	each	$20,000.00	$40,000.00
Coir Log Build-up		2	each	$8,000.00	$16,000.00
Boulder Build-up		2	each	$12,000.00	$24,000.00
Signage		1	ls	$12,000.00	$12,000.00
		Site Improvements Subtotal			$92,000.00
Catch Basin Improvements					
Catch basin inserts		4	ea	$500.00	$2,000.00
Upgrade catch basin to catch basin with sump		2	ea	$8,000.00	$16,000.00
		Inlet Improvements Subtotal			$18,000.00
Inlet Improvements					
Sediment Forebay		2	ea	$6,000.00	$12,000.00
Constructed Wetland	1/2 acre-foot	2	ea	$60,000.00	$120,000.00
Meandering Swale	200 ft in length	1	ea	$15,000.00	$15,000.00
		Inlet Improvements Subtotal			$147,000.00
Outlet Improvements					
Outlet		1	ls	$20,000.00	$20,000.00
		Outlet Improvements Subtotal			$20,000.00
	Subtotal				**$2,909,225.00**
General Construction Costs					
Mobilization (5%)					$145,461.25
General Conditions (7%)					$213,828.04
Overhead and Profit (7%)					$228,796.00
Escalation (3%)					$104,919.31
Contingency (15% overall)					$540,334.44
		TOTAL			**$4,142,564.04**

ONGOING LAND MANAGEMENT COSTS

While capital funding supports the design and construction work included in the master plan, most of the repairs, maintenance and on-going land management costs such as invasive species monitoring and tree pruning are funded through other means.

Even after the implementation of the master plan components, Chandler Pond will require routine investment to keep up with park usage, storm events, and the effects of time on the materials and landscape. Ultimately, the routine work that is done daily, monthly and annually will define the quality of the park experience.

On the following page is a budgeting diagram laying out some of the key features of the ongoing maintenance and land management costs that will be required to maintain the capital investments described in the master plan. Keep in mind that since the master plan is likely to be implemented in phases by task or by area, the sum total of these costs will never be required in any single year. However, there will be regular expenditures required to maintain the improvements laid out in the master plan.

Deferring maintenance leads to increased repair costs due to deterioration, increased replacement costs, liability from hazards, and a decline in the public perception of the park's quality or safety. Ultimately, budgeting for timely maintenance builds a more resilient park, reduces future costs and ensures safety.
Key pieces of the land management budgeting diagram include:

- Invasive monitoring and removal following the initial construction contract period (First three years of this work for each area tackled can be included in the capital budget for that project and handled by private contractors)
- Aquatic invasive species survey to evaluate the presence and extent of aquatic invasives
- Initial aquatic invasive herbicide treatment (may be funded through capital projects, as well)
- Ongoing aquatic invasive herbicide treatment
- Periodic water quality testing of the pond and its inlets
- Regular pruning of mature trees in the park for safety and tree health
- Trail surface maintenance and repair (allowance for repairing 5% of the trail surface annually, due to wear and tear, vandalism, etc.)
- Access point maintenance and repair (allowance for repairing 5% of the access point square footage annually due to wear and tear, vandalism, etc.)
- Regular cleaning of upgraded catch basins

The land management budget includes new costs that will arise as a result of master plan implementation. It is does not include costs that are already being incurred routinely, such as the regular mowing and trash pickup done by the by the Parks and Recreation Department. Note that the budget is also expressed in today's dollars, due to the uncertain implementation timeline. Adjust these values for inflation once the implementation schedule is determined.

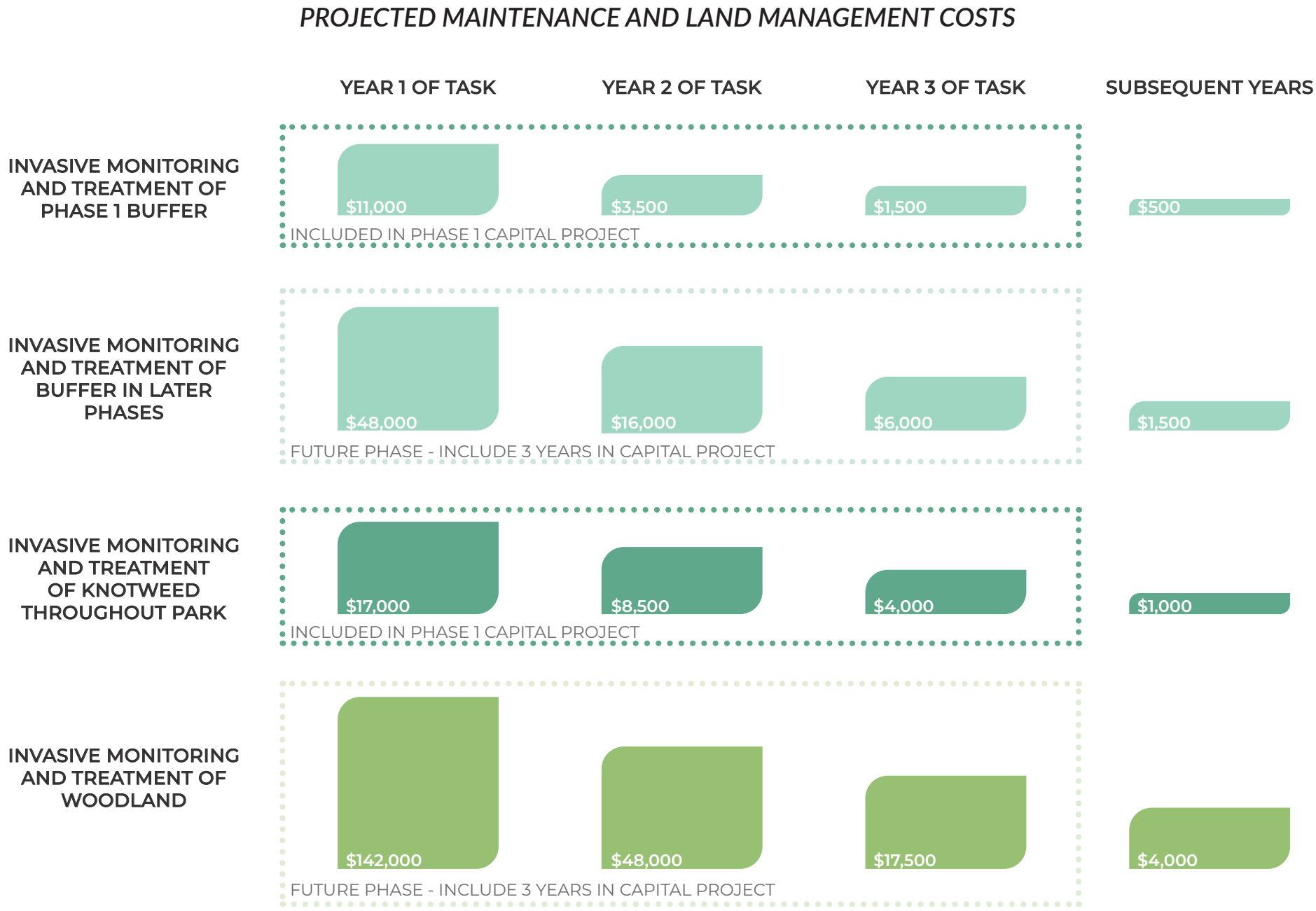


FIGURE A.1 LAND MANAGEMENT AND ONGOING MAINTENANCE BUDGET DIAGRAM

For terrestrial invasive species, Year 1 of Task is incurred the year following the completion of the capital/construction project. For aquatic invasive species monitoring, Year 1 of the Task is incurred the year of the task.

FIGURE A.1 LAND MANAGEMENT AND ONGOING MAINTENANCE BUDGET DIAGRAM (CONTINUED)
For terrestrial invasive species, Year 1 of Task is incurred the year following the completion of the capital/construction project. For aquatic invasive species monitoring, Year 1 of the Task is incurred the year of the task.

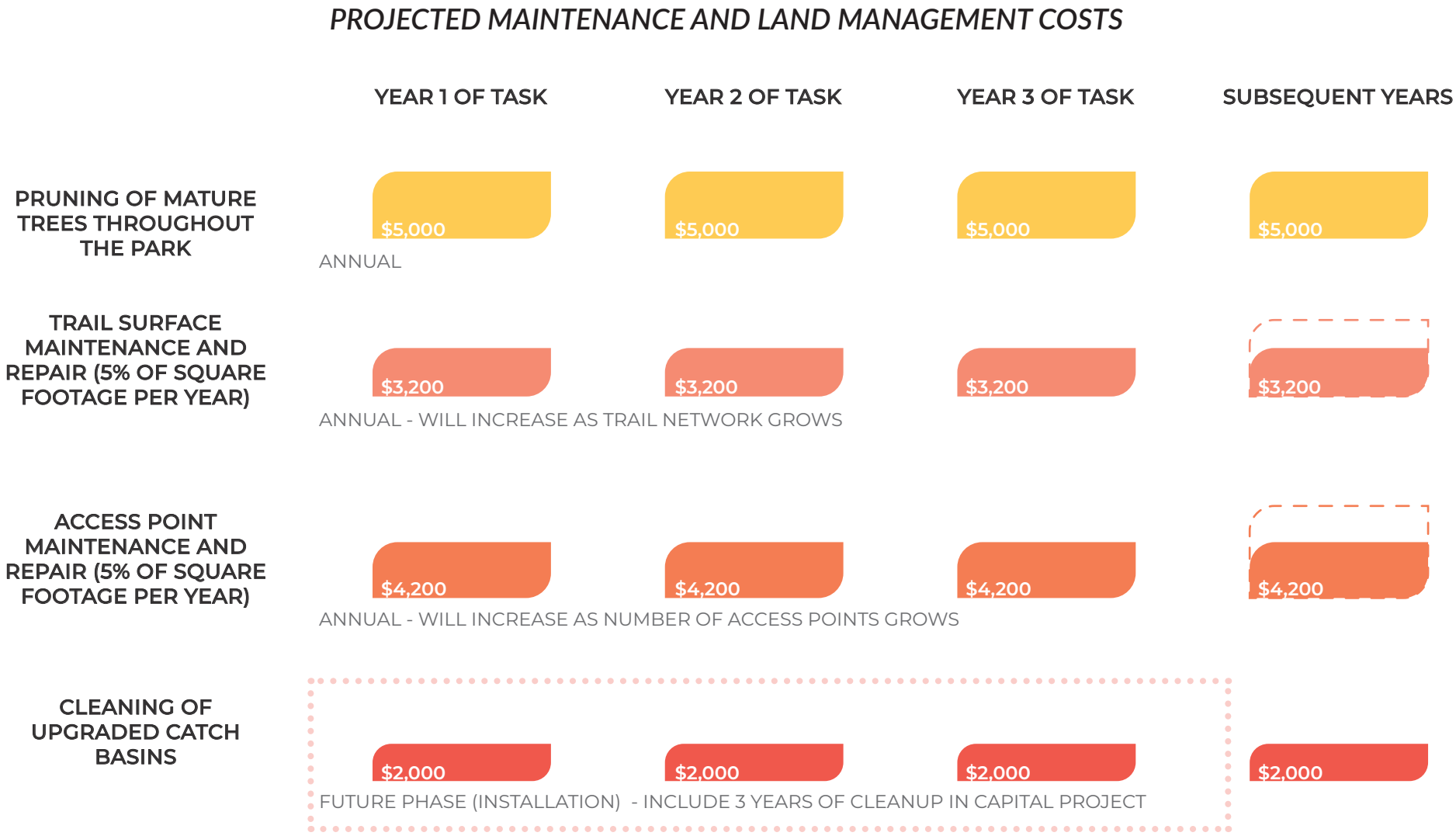


FIGURE A.1 LAND MANAGEMENT AND ONGOING MAINTENANCE BUDGET DIAGRAM (CONTINUED)

For terrestrial invasive species, Year 1 of Task is incurred the year following the completion of the capital/construction project. For aquatic invasive species monitoring, Year 1 of the Task is incurred the year of the task.

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