MUDDY BROOK WATERSHED

RESILIENCY MASTER PLAN – WARE, MA

Prepared by:

The Town of Ware's Muddy Brook Working Group and

The Pioneer Valley Planning Commission (PVPC)

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Ware, MA

MVP

Catalyst for Regional Progress PVPC

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SK Robinson, Muddy Brook Subwatershed Resident

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The Pioneer Valley Planning Commission

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EXECUTIVE SUMMARY

INTRODUCTION

The Muddy Brook Watershed Resiliency Master Plan identifies current and future threats to the Muddy Brook watershed and assesses strategies for increasing resiliency, reducing localized flooding, assessing the volume and velocity of storm flows, better protecting drinking water supplies, addressing failing infrastructure, and increasing the Muddy Brook Watershed's resiliency to climate change. The Plan develops a set of updated priority resiliency actions and strategies that reflect the current and future concerns and priorities related to protecting the environmental, water supply, recreational, and public health interests of the Muddy Brook Watershed. Resiliency is the ability to plan for, withstand and recover from severe events, without suffering permanent loss of functions, devastating damage, diminished productivity or decreased quality of life. Resilient watersheds are better able to respond and recover from extreme weather events, such as extreme precipitation events which in turn increase the likelihood of flooding.

The health of the Muddy Brook Watershed is critical for the Town. While the watershed area provides most of the drinking water for residents in Ware and lies within a valuable economic and social area of Town, the lower watershed has large amounts of impervious cover that contribute to heat island effects, higher stormwater runoff volumes, and water quality concerns for Muddy Brook.

As part of a 319-Grant funded Nonpoint Source Watershed Planner project, the Pioneer Valley Planning Commission (PVPC) identified the Muddy Brook watershed as a priority sub-watershed within the Chicopee River Basin for development of locally meaningful and effective multi-purpose projects that advance water quality improvements and climate resiliency. As planning for mitigation strategies for this watershed on a proactive basis is important to the Town of Ware, PVPC worked with the Town to obtain Massachusetts Municipal Vulnerability Preparedness (MVP) grant funding to conduct an initial analysis and plan for the watershed.

This MVP-grant funded plan includes consideration of climate change impacts that range from the ongoing changes in precipitation patterns from more frequent, smaller rainstorms to longer dry periods broken by intense rainfall events, to increases in temperature and impervious cover. The impacts of climate change in the Muddy Brook Watershed potentially include: increasing stormwater quantity and decreasing quality, impacts to the Town's drinking water supply aquifers, increasing riverine flooding, impacts to the ecological systems in the upland areas from changing temperatures, increasing invasive species, and increasing impervious area, and impacts to public health from increasing temperatures in the downtown stretch of the Muddy Brook Watershed.

PROJECT GOALS

The goals for the Muddy Brook Watershed Resiliency Master Plan project are three-fold:

1. Develop a watershed plan that characterizes current and future threats to the watershed and associated drinking water supplies from climate change and development and create a roadmap for increasing resiliency through identified areas of focus for improvements.

2. Conduct robust public engagement, particularly with Environmental Justice (EJ) communities within the watershed, to assist with identification of vulnerabilities and future actions, and to increase awareness of the importance of maintaining the health of the watershed.
3. Tee up projects for future applications to grant programs, including the Section 319 Water Quality and Municipal Vulnerability Preparedness programs.

The vision for the overall project is to create a process and provide instruction that can be used in other subwatersheds in the region through identification of shared strengths, vulnerabilities, and resiliency strategies addressing shared concerns such as drinking water aquifer protection and flooding. The proposed Master Plan will increase the resiliency of the subwatershed to the climate change impacts through:

- identification and analysis of current and future threats,
- development of strategies for reducing flooding and stormwater impacts across the watershed,
- identification of Town-owned parcels for installation of green infrastructure and other environmentally sensitive stormwater management facilities,
- identification of critical areas to focus on for future projects to soak up and slow flows, and
- identification of opportunities for land acquisition and conservation in floodplains and wetlands.

The Muddy Brook Watershed Resiliency Master Plan is available through the Town of Ware's website located at:

https://www.townofware.com/departments/planning_department/muddy_brook_subwatershed_resiliency_master_plan.php

CHAPTER 1: THE MUDDY BROOK WATERSHED

MUDDY BROOK (MAP 1)

The Muddy Brook Watershed starts at the Quabbin Reservoir and extends south through Hardwick into Ware, crossing conservation and wooded lands into large agricultural parcels, becoming suburban and finally more densely urban at the confluence with the Ware River in downtown Ware. The Watershed is classified as a healthy cold-water stream that supports a state-endangered mussel species and is not currently listed as an impaired water. Therefore, Muddy Brook does not have any applicable Total Maximum Daily Load (TMDL) requirements. The Muddy Brook Watershed is a very important watershed in the Town of Ware that includes both the Town's public water supply aquifer and a substantial geographic area of the Town, including two mapped Environmental Justice populations. Proactive protection of the watershed is important for ecological reasons as well as drinking water, recreation, and social equity purposes.

The Muddy Brook Watershed includes both the brook and the adjacent floodplains and wetlands. It has a drainage area of approximately 20 square miles and is identified by Natural Resources Conservation Service (NRCS) as Hydrologic Unit Code (HUC) ID- 010802040206. The bankfull width of Muddy Brook varies significantly across the watershed, averaging approximately 24-feet based on field measurements from four (4) different locations upstream of Snow Pond to the Hardwick Town Line. It should be noted that USGS Stream Stats lists the bankfull width as 49.3-feet.

SNOW POND

Snow Pond is a 25-acre impoundment managed by the Town of Ware Water Department. Snow Pond is a shallow pond, with a substantial portion of the pond being within the littoral zone. Littoral zones are delicate and easily disrupted by urban development, erosion, and recreation. When inundated with pollutants and stormwater runoff containing pet waste, motor oil, yard fertilizers, grass clippings, and materials resulting from industrial and agricultural practices, littoral zones can degrade. This creates ideal conditions for nuisance weeds, algae, toxic cyanobacteria, and invasive species to take over. Snow Pond once was a favorite destination for swimming, fishing, walking, and picnicking as it is close to the center of town. Now, extensive weed growth, coupled with nutrient loading, shoreline and watershed development and stormwater discharges have accelerated the natural

succession of Snow Pond, resulting in increased eutrophication. Unmanaged nuisance aquatic plant growth and degrading water quality has decreased the availability of high-quality fish and wildlife habitat, decreased aesthetics, and reduced the recreational appeal of the pond.

WETLAND RESOURCES

BORDERING VEGETATED WETLANDS (MAP 2)

Wetlands are part of our "common wealth." They contribute to public health and safety, not only for you and your family, but for your community as well. Wetlands protect drinking water, prevent storm damage, and provide fish, shellfish, and wildlife habitats. Wetlands also support commercial fishing, tourism, recreation, and educational opportunities. These valuable resource areas are found in every community across Massachusetts and are an important part of a river's watershed. Inland wetlands are areas where water is at or just below the surface of the ground. Although these wetlands can appear dry during some seasons, they contain enough water to support certain plants and soils. Inland wetlands include marshes, wet meadows, bogs, and swamps. Wetlands that border on ponds, lakes, rivers, and streams are called bordering vegetated wetlands. Wetlands are abundant along the Muddy Brook corridor.

Wetlands and the species they support face numerous threats including impacts from development, fragmentation, unsustainable water withdrawals, pollution, invasive species, and climate change. Protection of not only these wetlands but their upland buffers and surrounding watersheds will help minimize these impacts, maintain connectivity among habitats, and allow for essential natural processes that will support the long-term persistence and abundance of a wide diversity of wetland species and habitats. Wetlands have the bonus of acting as a filtration system. Wetland plants are natural filters so when runoff from parking lots, roads, and other paved surfaces reaches a wetland, pollutants like gasoline and oil are filtered out of the water before it reaches the groundwater system. When these wetlands are built upon, the pollutants are not filtered out and runoff from streets and parking lots may flow directly into groundwater or streams and rivers. Ware's wetlands are regulated by a Conservation Commission who administer and enforce the Wetlands Protection Act (WPA) and the Town of Ware's Wetlands Bylaw.

VERNAL POOLS (MAP 3)

A vernal pool is a contained depression lacking a permanent above ground outlet. In the Northeast, these basins fill with water from the rising water table during fall and winter or with the meltwater and runoff of winter and spring snow and rain. Many vernal pools in the Northeast are covered with ice in the winter months. They contain water for a few months in the spring and early summer. By late summer, a vernal pool is generally, but not always, dry. Many organisms with an aquatic stage in their life cycle have evolved to require these temporary and fish-free waters of vernal pools. These organisms are sometimes known as "obligate" vernal pool species because they do not breed successfully in water that supports fish. They require temporary pools. Vernal pools tend to be remarkably productive habitats from which significant biomass is created. Frogs and salamanders breed in large numbers and may produce thousands of larvae each year. Upon metamorphosis, tiny frogs and salamanders (aka

biomass) hop and crawl their way into the surrounding uplands, extending the food webs of the pool out into the woods around them.

There are 25 Certified Vernal Pools in the Muddy Brook Watershed and an additional 10 identified Potential Vernal Pools. The Muddy Brook Watershed also encompasses a Vernal Pool core habitat as identified in BioMap 3.

FLOODPLAINS (MAP 4)

Floodplains are regulated by the Federal Emergency Management Agency (FEMA) and terms used to describe floodplain areas include the 100-year floodplain, or 1% Annual Chance flood zone, and the 500-year floodplain, or 0.5% Annual Chance flood zone. Flood hazard areas are mapped by FEMA and can be seen on Map 4. Floodplains bordering Muddy Brook are primarily classified as A/AE. Flood Hazards A & AE are associated with the 100-year floodplain and designated as Bordering Land Subject to Flooding (BLSF) under the MA Wetlands Protection Act.

Floodplains provide numerous flood loss reduction benefits as a result of their unique natural functions. Rivers and streams shape floodplain topography and influence riparian habitats and riverine ecosystems. Likewise, the physical characteristics of the floodplain shape water flows and can provide flood loss reduction benefits. In their natural vegetated state, floodplains slow the rate at which the incoming overland flow reaches the main water body in the area. Vegetation also reduces shoreline erosion. In coastal areas, floodplain features such as beaches, sand bars, dunes and wetlands act as natural barriers to dissipate waves and protect back-lying areas from flooding and erosion.

A natural floodplain has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. Slowing runoff across the floodplain allows additional time for the runoff to infiltrate and recharge available groundwater aquifers when there is unused storage capacity. The slowing of runoff provides the additional benefit of natural purification of water as local runoff or overbank floodwater infiltrates and percolates through the floodplain alluvium (flat land area adjacent to a stream). Natural floodplains provide flood risk reduction benefits by slowing runoff and storing flood water. They also provide considerable economic, social, and environmental benefits and values that are often overlooked when local land-use decisions are made. The floodplain also serves as critical habitat for many plant and animal species and is typically an area with rich fertile soils.

RARE, THREATENED AND ENDANGERED SPECIES (MAP 5)

Endangered species are any species of plant or animal in danger of extinction throughout all or a significant portion of its range including, but not limited to, species listed from time to time as “endangered” under the provisions of the Federal Endangered Species Act of 1973, as amended, and species of plants or animals in danger of extirpation, as documented by biological research and inventory. Through the implementation of the Massachusetts Endangered Species Act (MESA), MassWildlife’s Natural Heritage and Endangered Species Program (NHESP) conserves and protects the most vulnerable animal and plant species and the habitats upon which they depend. Priority Habitat is the regulatory screening tool used by NHESP to review projects or activities for impacts to species listed under the MESA. The Muddy Brook Watershed contains two state designated Priority Habitat areas for Endangered Species. PH 1355 runs the length of Muddy Brook, beginning in Hardwick and ending at Snow

Pond and PH 1136 encompasses the terminus of Muddy Brook where it enters the Ware River. PH1136 continues to border the Ware River south through Palmer.

Several rare, threatened, or endangered species of animals are found in Ware. Blue-spotted Salamanders were reported from Ware in the 1800s, but not since then. Although the species is known from only scattered occurrences in the Quabbin area, there are recent records in nearby towns. Working with landowners to survey vernal pools in the spring may locate the species. Blue-spotted Salamanders inhabit upland forest during most of the year. In the spring, adults migrate to breed and lay their eggs in vernal pools, swamps, marshes, and other predominantly fish-free wetlands. After larvae metamorphose during late spring they disperse into upland forested areas.

Four-toed Salamanders nest in patches of sphagnum moss that overhang streams. The young drop into the streams where they live until maturity, at which time they move to nearby forests. While not an obligate vernal pool species, the occurrences in Ware are in an area with a cluster of certified and potential vernal pools in BioMap3 Core 1694 as well as in Core 1704 in the Aquatic Core along Muddy Brook.

Wood Turtles have been reported in multiple areas throughout Ware, particularly along Muddy Brook. Wood Turtle habitat is comprised of streams and rivers, primarily with long corridors of connected uplands extending on both sides of the waterways. Most turtle species known in Ware nest in sandy upland areas and are susceptible to a high mortality rate when they move through parts of their habitats, particularly where they must cross roads. Because turtles have low nest and juvenile survivorship, losing only a few adults annually can cause populations to decline because.

Ware has two state-listed species of freshwater mussel (Brook Floaters & Creepers) and another that was recently removed from the list and remains of conservation interest (Triangle Floaters). The presence of these species in local streams, particularly Muddy Brook and the Ware River, confirms the importance of maintaining the clean, flowing waters for these species and others that share these habitats. Freshwater mussels are important to clean water and fish habitat. As filter feeders, they eat algae and bacteria in the water and clean our streams and ponds. They also provide structure for the stream bottom or lakebed, improving habitat for other invertebrates and fish. Brook Floater (or Swollen Wedge mussel) are small freshwater mussels that inhabit streams and rivers with low to moderate water velocities, stable substrates, low nutrients and good water quality. They are currently known in only four water bodies in the state, making Ware's population very important. Creepers are freshwater mussels that inhabit low-gradient reaches of small to large rivers with sand or gravel substrates. Creepers are best supported by cool to warm waters with diverse fish assemblages. Triangle Floaters are commonly found in low-gradient river reaches with sand and gravel substrates and low to moderate water velocities.

The rare plant species found in Ware grow in moist woods along streams or in swamps. Narrow-leaved Spring Beauty typically occurs in deciduous forests on upper floodplain terraces and adjacent to slopes. These areas have moist fertile soils and are subject to infrequent flooding events. Swamp Lousewort grows in open areas that are periodically flooded such as wet meadows, marsh edges, and stream banks. It occurs primarily in calcareous soils. Great Laurel, a member of the Heath family, is an evergreen shrub or small tree that grows up to 10 meters high. Its natural habitat consists of moist woods, swamps, and the edges of ponds. One-flowered Pyrola (also called Single Delight) is a short herbaceous plant of moist forests with a single white, waxy flower.

BIOMAP 3 CORE HABITAT AND CRITICAL NATURAL LANDSCAPE (MAP 6)

BioMap3 is a non-regulatory conservation planning tool to plan and prioritize conservation actions. The Massachusetts Division of Fisheries and Wildlife (MassWildlife) and The Nature Conservancy (TNC) in Massachusetts developed BioMap3 to identify critical lands and waters throughout the Commonwealth in need of conservation. BioMap3 delivers the latest scientific data and resources to help state and local governments, land trusts, non-government organizations, and other conservation partners strategically protect and manage the habitats and ecosystems critical for biodiversity conservation. BioMap3 Core Habitat and Critical Natural Landscape identify intact fish and wildlife habitats, natural communities, ecosystems, and landscapes that are the focus of the Massachusetts State Wildlife Action Plan (SWAP). BioMap3 integrates MassWildlife's extensive rare species database and fish and wildlife data with TNC's assessment of large, resilient, and well-connected ecosystems and landscapes across the Commonwealth, supporting species in the context of a changing climate. Protection and stewardship of Core Habitat and Critical Natural Landscapes are essential to safeguard the diversity and abundance of species and their habitats across Massachusetts, as well as the wellbeing of the people of the Commonwealth.

Core Habitat identifies areas that are critical for the long-term persistence of rare species, exemplary natural communities, and resilient ecosystems across the Commonwealth. Core Habitat contains six components of biodiversity conservation including Rare Species Core, Forest Core, Aquatic Core, Wetland Core, Vernal Pool Core, and Priority Natural Communities.

Critical Natural Landscape identifies large landscape blocks that are minimally impacted by development as well as buffers to core habitats and coastal areas, both of which enhance connectivity and resilience. These areas provide habitat for wide-ranging native species, support intact ecological processes, maintain connectivity among habitats, and enhance ecological resilience to natural and anthropogenic disturbances in a rapidly changing world. Areas are delineated as Critical Natural Landscape include Landscape Blocks, Coastal Adaptation Areas, Tern Foraging Habitat, Aquatic Core Buffer, and Wetland Core Buffer.

Local Components are additions to Core Habitat and Critical Natural Landscape assessed from the perspective of each city and town to inform municipalities and others when making local decisions. Local Components includes Local Landscapes, Local Wetland and Local Wetland Buffer, Local Rare Species, Local Aquatic Habitat and Local Aquatic Habitat Buffer, and Local Vernal Pools. Please note the local data is not designed to replace the statewide data, but to complement and add to it. It is important to use the local layers and statewide data together.

Regional Components are additions to BioMap3 that are of particular importance for conservation from the perspective of the Northeastern United States. Regional Connectivity shows areas that are particularly important for maintaining sub-continental connections among habitats, which will support the shifting ranges of native species. Regional Rare Species areas identify habitats within the state that support highly vulnerable and imperiled species which are at high risk regionally, nationally, or globally due to factors such as restricted ranges, few populations or occurrences, history of decline, and high threat levels.

Several of the BioMap3 Core Habitats are located within the Muddy Brook Watershed including Aquatic Cores and Wetland Cores designated to the riparian area of the Brook. Aquatic Cores contains freshwater habitats (rivers, streams, lakes and ponds) with the highest fish and freshwater mussel diversity, strongest anadromous

(migratory) fish runs, aquatic rare species habitat, and habitats most resilient to a warming climate. These areas represent the most structurally and functionally intact freshwater ecosystems in the Commonwealth. Climate change significantly affects the structure and function of aquatic ecosystems both directly and indirectly. Direct effects include increases in water temperatures and changes to hydrology, while indirect effects may alter plant and animal communities, and accelerate the spread of invasive species. Aquatic habitats are particularly susceptible to these changes because habitat conditions like water temperature and the amount of water are climate-dependent, species that inhabit them are less able to disperse, and multiple stressors are already impacting them.

Wetland Core comprises the most intact, least disturbed wetlands within resilient landscapes—those with intact buffers, hydrological integrity, and areas with little fragmentation or other stressors associated with development. These wetlands are most likely to support diverse plant and animal habitats as well as critical wetland functions, and they are most likely to maintain these functions into the future. Also included are wetland-dependent rare species habitats and priority wetland natural communities. BioMap3 includes both Wetland Core, assessed from a statewide perspective, and Local Wetlands, assessed from the perspective of each city and town.

In addition, BioMap3 has also identified Local Critical Natural Landscapes blocks within the Muddy Brook Watershed. Both Aquatic Core Buffers and Wetland Core Buffers have been identified along the Muddy Brook Corridor. The Dougal ridge in the northeastern part of town, shown as BioMap3 Supporting Natural Landscape (SNL) between Muddy Brook and the Ware River, supports several rare species, many vernal pools (certified and potential), and an older forest, all of which are all primary biodiversity interest.

CHAPTER 2: THE PLANNING PROCESS

ENGAGEMENT OVERVIEW

Public Involvement and Community Engagement will consist of the creation and maintenance of a dedicated Town webpage for project materials and a link to contact the Working Group with feedback, development and distribution of mailed non-point source pollution prevention outreach materials to residents and businesses within the watershed, and transcripts of the Working Group meetings and stakeholder interviews. The non-point source material content and messaging will be tailored to local groups via input from the community liaison and the Working Group. Interviews of stakeholders within the watershed regarding their hopes and concerns for the future for the watershed are proposed to be transcribed and available online.

ENVIRONMENTAL JUSTICE POPULATIONS (MAP 7)

In Massachusetts, an Environmental Justice (EJ) population is a neighborhood where one or more of the following criteria are true:

1. the annual median household income is 65 percent or less of the statewide annual median household income;
2. minorities make up 40 percent or more of the population;
3. 25 percent or more of households identify as speaking English less than "very well"; and
4. minorities make up 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

Based on the 2020 Census, there are two Environmental Justice (EJ) neighborhoods in the lower reaches of Muddy Brook, designated based on Minority and Income in Block Group 3, Census Tract 8201.02 in the vicinity of the Snow Pond impoundment, and Income in Block Group 2, Census Tract 8201.02, in the downtown area where Muddy Brook meets the Ware River. By identifying opportunities to improve water quality, reduce localized flooding, remove impervious surfaces, and enhance recreational opportunities along Muddy Brook and Snow Pond, the Muddy Brook Watershed Master Plan will define a program to improve resiliency, safety, and quality of life in these neighborhoods.

According to the most recent EJScreen data, the Muddy Brook Watershed has a Disadvantaged EJ Population based on low income (87 percent compared to MA). Income levels in the Muddy Brook Watershed are much lower than the Commonwealths average. For example, 3 percent of the population has an income under $35,000, 45 percent of the population has an income under $50,000, and 65 percent of the population has an income under $75,000. The poverty rate in the target area (18 percent) is nearly double the Commonwealths rate (9.8 percent). The median household income ($42,905) is about half of the Commonwealths median household income ($84,385). The extreme poverty rate in the target area is magnified due to the current state of the economy and significant inflation for basic necessities including food, energy, gas and healthcare that have further increased the burden on the underserved communities and sensitive populations. This tract also has a higher percentage of people ages 25 years or older whose education level is less than a high school diploma (12 percent) than the

national average (10 percent); and has a much higher percentage of the population 15 or older not enrolled in college, university, or graduate school (93 percent).

The Muddy Brook Watershed includes disproportionately high populations with elevated health risks and environmental sensitivities: 26 percent of the population are children under the age of 19 and 11 percent are seniors aged 65 or over. In addition, housing costs are at the 86th percentile, lead paint at the 86th percentile, asthma at the 87th percentile, heart disease 69th percentile, low life expectancy 77th percentile, ozone at the 81st percentile, lead paint at the 74th percentile. The MA Department of Public Health (DPH) data shows that 26 women in Tract 8201.02 gave birth in 2020, with 77 percent of them receiving some form of public assistance. Environmental factors negatively impact the Watershed at higher rates than the state, EPA region, and country. Lead paint is in the 80th percentile compared to MA average; ozone in the 69th percentile compared to the MA average; and heart disease in the 74th percentile as compared to MA average.

PUBLIC INVOLVEMENT

WORKING GROUP (SEE APPENDIX C)

The Working Group was established in October 2022. The Working Group consisted of a mix of representatives of Town boards, committees, departments, volunteers who represent the residents within the subwatershed area, businesses within the subwatershed area, and the Environmental Justice community (through the use of community liaisons). The Working Group members assisted with the identification of opportunities for land acquisition and conservation in floodplains and wetlands based on water supply protection needs, recreation needs, current and future threats, and areas of known current and anticipated future flooding that would impact public health and safety.

The responsibilities of the Working Group are to provide local knowledge and expertise, assist with development and distribution of public outreach materials, assist with publicization of public events, and to meet every other month to review Plan chapters and deliverables. The kickoff meeting was held October 24, 2022, and had 11 participants. The Working Group discussed the scope of the grant, public outreach, and adding representatives not previously identified in the original proposal. Key underserved populations identified were the elderly, religious organizations, and indigenous peoples.

The second Working Group Meeting was held November 15, 2022. The Working Group discussed current and future threats to the watershed. Current and future threats were discussed in terms of overall categories including known or potential future development, on-site septic system failure, agricultural uses/issues, hazardous materials, transportation corridors, stormwater runoff, pesticide/herbicide/fertilizer use, invasive species, riverbank erosion/loss of riparian buffer, point source pollution, climate change, and habitat loss.

The third Working Group Meeting was held September 12, 2023. This meeting was to discuss what occurred in Year One of the grant and review the deliverables and timeline for Year Two. The primary focus of the meeting was to plan our public outreach and engagement activities for the year. This included regular updates of the Town webpage for project information and feedback from the group on what additional information should be included on the webpage. The working group also developed a plan to create and distribute non-point source pollution

prevention outreach materials to residents and businesses within the watershed area using the website and town water bills. Lastly, the working group reviewed the current draft chapters of the Muddy Brook Subwatershed Resiliency Master Plan.

The fourth Working Group Meeting was held November 30, 2023. The Working Group reviewed and proposed amendments to the existing deliverables of the MVP grant. This resulted from our review of existing regulatory code relative to water supply Zone II land uses and protections, stormwater management, and use of green infrastructure strategies where the Working Group determined the only need to code changes was the development of a Stormwater Bylaw. At this time, the Town did not have a Stormwater bylaw and is not a MS4 regulated community. Changes to tasks in the grant were agreed upon by the Working Group and submitted to the MVP Regional Coordinator for approval. Various changes throughout Year Two Tasks, included:

- Simplification of Regulatory Review to development of a Stormwater Bylaw and chapter recommending developer incentives only;
- Increase funding for Project Administration;
- Increase funding for Public Participation and Outreach;
- Remove repetitive tasks completed this year through other outlets including the removal of Sub-task 8.3 Analysis of needed improvements to recreational opportunities & Sub-task 8.4 Identification of strategies to improve effectiveness of flood control levee system at Muddy Brook's confluence with Ware River, as they have recently been completed through the 2023 Open Space & Recreation Plan update (task 8.3) and Army Corps Of Engineers yearly inspection of the levees (task 8.4).

The fifth Working Group Meeting was held January 11, 2024. The Working Group focused on Stakeholder interviews. Specifically, the group developed a list of people to interview, reviewed & finalized the Interview Questions and developed a schedule for the interviews. This meeting also included a presentation from Bob Hartzel, from Comprehensive Environmental Incorporated (CEI) on the development of the concurrent Watershed Based Plan for Muddy Brook. The top 12 sites to implement Best Management Practices (BMPs) were determined and a site visit was scheduled with CEI to look at the sites proposed and develop the most appropriate BMPs for each location.

The sixth Working Group Meeting was held March 14, 2024. At this meeting the Working Group reviewed the draft report summarizing developer incentives to support green infrastructure/reduce impervious surface using examples from other MA communities as a template. The Working Group weighed the pros and cons of the various approaches and attempted to develop recommendations for incentives that can be incorporated into the regulatory revision process. Everything the group reviewed would not work for Ware currently, as they do not have a Stormwater Bylaw so there is no mechanism in place to allow developer incentives. Most incentives are in municipalities that have stormwater bylaws, stormwater utilities and financial incentives which aren't feasible for Ware. What could work for Ware is a certification that shows that developers are using green infrastructure and low impact development in their site plans. It could act as a small reward. The group did agree to do a town wide community rain barrel program with the Great American Rain Barrel Company to begin getting residents to think about their part in reducing stormwater through a simple affordable measure.

The seventh Working Group Meeting was held April 11, 2024. This meeting began with a presentation from Todd Olanyk, from the Department of Fish and Game (DFG) on the upper Muddy Brook Restoration Efforts and the Patrill Hollow Dam Removal project in Hardwick. Following Todd's presentation, Bill Zini, Chair of the Hardwick

Conservation Commission gave a separate presentation on the Muddy Brook Aquifer and the importance of the aquifer for the Town's drinking water supplies. After the two guest presentations, the working group collaborated with congregates from the United Church of Ware to Plan the Watershed Celebration on May 18th 2024.

The eighth Working Group Meeting was held May 9, 2024. This meeting was dedicated to finalizing plans for the Watershed celebration. The final Working Group meeting was held June 13, 2024. This meeting was to review the final draft of the plan and add any additional information gathered from the Watershed Celebration held on May 18th and from the Planning Board presentation held on June 6th. Agenda's, Meeting Minutes and Sign-in Sheet for the Working Group meetings are included in Appendix C.

COMMUNITY LIAISONS

The project used the community liaison model to ensure that the viewpoint of the Environmental Justice communities is represented on the Master Plan committee. Public outreach and engagement events occurred at locations within or near the Environmental Justice areas in coordination with local neighborhood groups and religious organizations, including the United Church of Ware. The goal of the community outreach was to identify key concerns residents have related to water quality and to increase climate resiliency for the Environmental Justice areas in the lower reaches of Muddy Brook. The three Community Liaisons that participated in the planning process include:

- Dan Flynn, President of the Ware Business and Civic Association;
- Rev. Carole Bull, Pastor, United Church of Ware; and
- SK Robinson, Muddy Brook Subwatershed Resident

During the grant, the liaisons organized, promoted, and facilitated engagement activities with members of the community to gather insight about community needs and factors that contribute to identifying risks and threats to the Muddy Brook Watershed. The liaisons created and distributed public outreach materials related to stormwater management and water quality protection, attended pop up events to gather input, and shared information with the community. The liaisons attended the Working Group meetings and assisted with identifying and developing implementation projects that supported increasing resilience in the Muddy Brook Watershed. The use of community liaisons was invaluable to the project, as they worked to build, develop and maintain trusting relationships with community members that will serve the Town of Ware in future grant and implementation projects.

As a final task, the liaisons were asked to share their experience with the group. The Rev. Carol Bull stated:

> *"After each step I took, I reported back to my church congregation from the pulpit about the work we have been undertaking with this grant. On April 28th of this year, to mark Earth Day, I preached my first sermon on Climate, and our congregation has taken two constructive climate change steps because of that sermon. The most significant is that just yesterday (June 12, 2024), we've had 16 trees donated and planted on our property that we will steward.*

Having had little knowledge of climate issues, being involved with the robust efforts of Ware's public servants and consultants, along with my congregation, has been life-changing for me. I now am pursuing my interest in this topic through study and bringing my knowledge back to my congregation at regular intervals. They, in turn, understand that the city and their government bodies are concerned about the environmental issues in Ware. Many of those who attend services are members of the Environmental Justice populations that need special attention due to climate change.

I enjoyed attending our public outreach event held recently. A group of people attended and approached me to discuss their concerns about the committee's work. I was able to listen well and talk them through their worries. I also pointed them to our "expert" from the Pioneer Planning Commission so they could learn from her expertise and also from other experts who attended. It was a good reminder that citizens are often people who love the area they live in (in this case, they were abutters to Snow Pond.) With that love often comes skepticism that others who don't live where they do might do damage instead of good. We were able to get their buy-in through an activity where I wrote down the names of the birds, animals and wildlife who live where they live that matter to them most of all! I also went with committee members on a tour of the Subwatershed area where I learned much more than I could have done on my own."

COMMUNITY ENGAGEMENT

STAKEHOLDER IDENTIFICATION AND INTERVIEWS (SEE APPENDIX D)

Beginning at the Working Group meeting held on November 30, 2023, the Group conducted a stakeholder mapping exercise to identify stakeholders for interviews. The following five stakeholders were selected based on their broad representation of interests pertaining to the future of Muddy Brook. Stakeholders interviewed include:

- Tom Barnes, Vice-Chair of the Ware Conservation Commission;
- Geoffrey McAlmond, Department of Public Works Director;
- John Piechota, Parks & Recreation Director;
- Keith Davies, Chicopee 4 Rivers Watershed Council; and
- Bill Zini, former US Fish & Wildlife Service Employee and Chair of the Hardwick Conservation Commission

Stakeholder interviews were conducted in person during April and the questions and responses are included in Appendix D and have been posted to the Town's Muddy Brook webpage.

In addition to stakeholder interviews, a questionnaire was mailed to all abutters to Snow Pond. The goal of the questionnaire was to gather personal and local knowledge about the Muddy Brook Watershed and Snow Pond in particular. Throughout the process the Working Group realized they needed to incorporate more local knowledge into the Plan to provide important insight and context that was missing from the municipal Working Group. Another reason the Working Group chose to conduct direct outreach to abutters of Snow Pond was a potential recommendation identified by the Group to explore the feasibility of the removal of Snow Pond Dam. As direct abutters to Snow Pond, the Working Group decided the people who would be the most impacted by dam removal should be the first people involved in conversations surrounding the idea and lead decisions made about the future of Snow Pond. Questions asked of abutters included:

1. What do you like most about living in Ware and why?
2. What do you know about Muddy Brook? (location, water quality, usage)?
3. Describe the history of Snow Pond as you see it?
4. Have you ever used Snow's Pond recreationally? If so, for what (fishing, swimming, canoe/kayaking)?
5. What do you think its current condition is?
6. What management of the Pond is needed (if any)?
7. What values does Snow Pond hold for the Town (social, cultural, historical)?
8. Would you support the removal of Snow Pond Dam and the restoration of the brook to its natural condition?

Three responses were received back from residents, and many residents who received the questionnaire attend the Watershed Celebration of May 18, 2024.

PUBLIC EDUCATION AND OUTREACH

The development of the Muddy Brook Subwatershed Resiliency Master Plan included a strong public outreach and engagement component to both ensure meaningful participation in addressing future threats and mitigation actions, and to educate the public about the importance of protecting the Muddy Brook watershed.

https://www.townofware.com/departments/planning_department/muddy_brook_subwatershed_resiliency_master_plan.php

WATERSHED CELEBRATION (SEE APPENDIX E)

A Watershed Celebration public event was held Saturday May 18, 2024, at Hillside Village in Ware. The goal of the event was to increase social equity by ensuring that the people and communities experiencing the greatest climate risks were informed and able to help define climate resilience solutions for the Muddy Brook Watershed that meet their specific community needs. The location of Hillside Village was chosen as a central location for the EJ populations, and the event included free activities for kids (face painting, ice-cream, interactive demonstrations, coloring activities) and refreshments. The event was to bring awareness of the importance of Muddy Brook to the Town and discuss the potential threats to the health of the watershed and identify existing gaps in the draft Master Plan. The event was scheduled at a date, time and location convenient to families - especially those of Ware's EJ Community.

Several public educational tables were set up, including: the Chicopee 4 Rivers Watershed Council, MA Department of Fish & Game, Muddy Brook Working Group, Great American Rain Barrel Company and the CT River Stormwater Coalition. Enviroscape Non-Point Source pollution interactive demonstrations were conducted throughout the day and all residents were encouraged to take the "Muddy Brook Watershed Pledge". A participatory mapping session was held with residents to integrate local knowledge of Snow Pond and the Muddy Brook Watershed into the draft Plan by identifying gaps, issues and opportunities to increase resilience. Protecting and enhancing recreational opportunities associated with Snow Pond was a top priority to all in attendance.

The overarching concern of all residents in attendance was the restoration of Snow Pond. Residents expressed the need to have the Pond professionally surveyed to determine the species composition and density of invasive

species in Snow Pond and to identify potential restoration opportunities to decrease the eutrophication of the pond and restore it as a recreational asset to the Town. They believed over the past several years even the amount of wildlife that used the pond has significantly decreased and correlated it to the significant spreading of invasive species. In lake and shoreline invasive vegetation are outcompeting native species, resulting in a nuisance to the town and abutters. All in attendance requested this Master Plan include a section on what would be required to restore the Pond and a detailed map showing the composition and location of the aquatic invasive species.

COMMUNITY RAIN BARREL PROGRAM

As part of increasing public education and awareness about stormwater and green infrastructure the Town of Ware is holding its first Community Rain Barrel Program. Educating and encouraging local residents to use a rain barrel is one of the many ways homeowners can be part of the solution. Ware has partnered with the Town of Belchertown and the Great American Rain Barrel Company and residents can purchase Rain Barrels for $89. The Rain Barrels will be available for pick up on Saturday, July 13th from 10:00am-1:00pm at the Ware Highway Department 18 Mechanic St. Ware MA. The deadline for purchase is June 30th, Midnight.

A rain barrel can collect the runoff from roofs and gutters preventing the rain from making its way to impervious surfaces, which often end up in local streams, rivers, pond, lakes and marine waters. Keeping and using rain water on your property helps reduce pollution, erosion and improves local watershed health. A 500 square foot roof can fill a properly installed 50-gallon rain barrel in about one hour. A modest amount of rainfall can supply much or all of the outdoor watering needs. A full rain barrel will water a 200-square-foot garden. During severe drought, rain barrels can provide an additional source of water

IDEAS FOR FURTHER PUBLIC EDUCATION, OUTREACH AND PARTICIPATION

Creating and sustaining a public education program creates expectations that greater awareness will influence behavior and habits that exacerbate the problems of stormwater and water pollution in general. An informed community can also be enlisted to aid in the identification of illicit discharges. To provide relevant information to the community, targeted educational and outreach materials should be developed for residents and businesses and/or existing materials developed by the Environmental Protection Agency (EPA) and the MA Department of Environmental Protection (DEP) should be used and modified as necessary.

In addition to public education, getting the public to participate in events such as:

- Earth Day events & town wide clean-ups;
- Educational booths at Town Events (First Night, 4th of July, Carnival, etc.);
- River clean-ups (CT River Conservancy Source 2 Sea Clean-up);
- Adopt-a-Drain and Catch basin stenciling programs;
- Hotline/Webline for reporting problems, violations;
- Household hazardous waste/used oil collection days;
- Partnerships with advocacy groups;
- Stormwater workshops;
- Public surveys about opinions, behaviors; and
- Stormwater committee/task force;

CHAPTER 3: RISK ASSESSMENT AND VULNERABILITIES (MAP 8)

INTRODUCTION

This chapter describes the setting and the factors that influence current and future risk in the watershed to focus goals and actions needed to increase climate resiliency across the Muddy Brook Watershed. The summary of current and future threats to the Muddy Brook watershed is based on a desktop analysis of watershed features utilizing data layers from MassGIS, previous Town reports, and local knowledge provided by the Working Group.

LAND USE

Land use within the Muddy Brook Watershed is primarily low to high density residential, protected open space and recreation areas, commercial and industrial development, and agricultural. Key threats include known or potential future developments, agriculture, hazardous materials, and existing transportation corridors and habitat loss.

CURRENT AND POTENTIAL FUTURE DEVELOPMENT WITHIN THE MUDDY BROOK WATERSHED

Housing development varies dramatically within the Muddy Brook Watershed. Like many urbanized communities, Ware is trying to focus new residential development closer to the downtown area where public utilities (water and sewer) and facilities (parks and sports fields) are available. Ware's urbanized area is located at the southern end of the Muddy Brook watershed, near its confluence with the Ware River. Pedestrian facilities in Ware are concentrated in the more densely developed areas of downtown and extend south on Route 32 to the Ware Junior/High School.

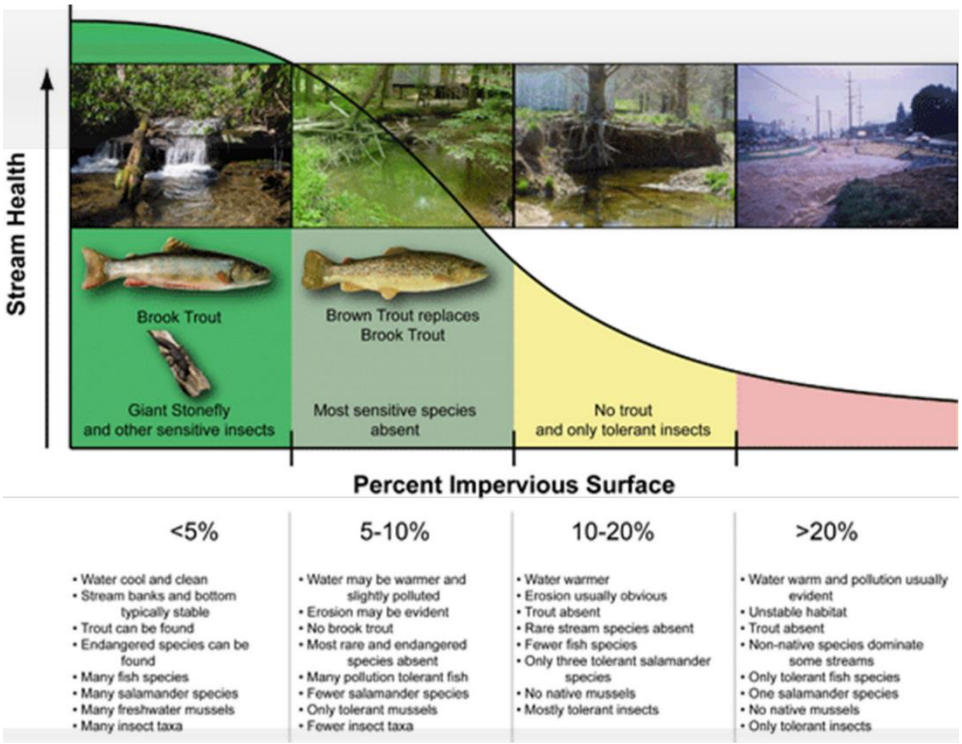
Ware's 2018 MVP Summary of Findings identified that rehabilitating vacant or condemned downtown private property near Muddy Brook could increase social and economic vitality and resilience to hazard events. Environmental Justice populations associated with the lower reaches of Muddy Brook were identified as at risk to hazard impacts and climate shifts. The mitigation actions and strategies presented in the 2018 Summary of Findings, however, are not clear about how to address the identified vulnerabilities to the Town's water supply, social and economic health, and Environmental Justice communities. In response to the oversight of the original MVP process, the working group identified developing a housing rehabilitation plan that will prioritize vacant and condemned lots to be rehabilitated to low-income housing. It was also recommended to create a detailed inventory of suitable property in town for the development of affordable, mixed income, mixed use, and assisted living housing and to promote the development of housing for older adults that is located within walking distance of the Town center, parks and services.

The Working Group identified several potential future developments as threats to the watershed including proposed large scale solar arrays, gravel mining operation, and increased subdivisions likely to be located in the northern part of the watershed. In all the potential new developments, lack of construction oversight can become one of the biggest threats to the watershed. Lack of adequate stormwater controls can contribute a significant amount of sediment to nearby bodies of water as sediment reduces stream capacity, interferes with fish life cycles, and can carry unwanted nutrients. In the downtown area, development is more likely to take place as mixed-use

redevelopment which could alleviate some threats of new development if constructed properly. Redevelopment or reuse of abandoned or blighted properties would reduce land disturbance activities and could incorporate environmentally sensitive site design to increase green space while simultaneously decreasing impervious surface cover. Additionally, the adoption of a local Stormwater Bylaw and supporting regulation would mitigate against the impacts of land disturbance for new development by providing a local regulatory mechanism to require construction oversight and promote Low Impact development (LID).

Impervious surface refers to all hard surfaces like paved roads, parking lots, roofs, and even highly compacted soils like sports fields. The problem with impervious surfaces is that they prevent the natural soaking of rainwater into the ground and slowly seeping into streams. Instead, the rainwater accumulates and flows rapidly into storm drains. Storm drains deliver large volumes of water to streams at higher velocities than would occur naturally, resulting in flooding and bank erosion. Pollutants, including gasoline, oil, fertilizers, trash, pet waste, etc., accumulate on impervious surfaces and are washed into the streams. Stream inhabitants are stressed, displaced, or killed by the fast-moving water and the debris and sediment it brings with it. Furthermore, during warm weather, rain that falls on impervious surfaces becomes superheated and can stress or kill cold-water fisheries inhabitants. As shown on the diagram below, all stream inhabitants are harmed by impervious surfaces, but some are more sensitive than others. Brook trout, for example, are not found in watersheds with more than 4 percent impervious surface. Some salamanders disappear from watersheds with as little as 0.3 percent impervious surface.

Figure 1. Illustration of Stream Health vs Percent Impervious Surface[1]



[1] From Maryland Department of Natural Resources Stream Health https://dnr.maryland.gov/streams/Pages/streamhealth/How-Impervious-Surface-Impacts-Stream-Health.aspx

AGRICULTURAL ACTIVITIES

Between 1971 and 2005 Ware's farmland acreage decreased by 71 percent. Approximately 3 percent of the watershed is agricultural land use and most agricultural activities within the Muddy Brook Watershed are located in the northern section of Town. Much of Ware's undeveloped, forested land is in private ownership. Currently, over 1,647 acres of privately owned open lands are enrolled in MGL Chapter 61A for agricultural use, or 6.4 percent of town acreage. Pesticides, fertilizers, and manure have the potential to contaminate Muddy Brook and the drinking water source if improperly stored, applied, or disposed. Farms also often have large maintenance garages for equipment and storage tanks that can potentially be sources of contamination due to leaks or spills of the products they store if improperly managed. Additionally, if livestock are permitted to freely access the areas adjacent to Muddy Brook and its tributaries, they can cause loss of the riparian buffer, bank erosion, and contamination of the brook with sediment and manure.

The Working Group identified the largest farm within the Muddy Brook Watershed as the Five Star Alpaca Farm on Old Gilbertville Road. The farm is approximately 28 acres and appears to be well managed based on desktop review. The Working Group identified the second largest farm as a livestock operation located on Hardwick Pond Road in the northern part of the watershed. This agricultural operation lacks appropriate BMPs to minimize erosion and pollution into Muddy Brook. Muddy Brook transects the property and there is a bordering vegetated wetland associated with the Brook that are degrading due to uncontrolled runoff. There are currently no protections in place on this farm for Muddy Brook. Equipment is left outside exposed to weather. Activities on the farm encroach on the brook and cattle have been observed and reported to be in Muddy Brook itself. One option could be to partner with the Mass Association of Conservation Districts to work with the property owner to establish appropriate agricultural BMPs and encourage the establishment of a minimal vegetated buffer (50-foot min) for Muddy Brook. These activities would significantly improve water quality entering Muddy Brook.

HAZARDOUS MATERIALS STORAGE

Approximately 1 percent of the Muddy Brook Watershed is mapped as commercial/industrial land use. Many businesses use hazardous materials, produce hazardous waste products, and/or store large quantities of hazardous materials. If hazardous materials are improperly stored, used, or disposed of, they become potential sources of contamination. Hazardous materials should never be allowed to enter a catch basin, septic system or floor drain leading directly to the ground. Activities within the Zone II Wellhead Protection Area may also pose a potential threat to the water supply. Specifically, under conditions when a river contributes water to an aquifer, an accidental release to the river may pose a threat to water quality.

Common potential sources of hazardous materials include:

- Household hazardous materials - automotive wastes, solvents, pesticides, and fertilizers;
- Heating oil storage – underground and above ground fuel oil storage tanks; and
- Commercial/industrial hazardous waste – many businesses store, use, and/or produce hazardous waste products and materials.

The Working Group was not familiar with any large producers or storage places of hazardous materials. There are several businesses within the downtown area that have been identified by DEP as Small Quantity Generators of hazardous materials, and there are two known historic oil spills that were reported and remediated at residential sites within the watershed. There are, however, two known historic dumping sites for trash and construction materials: the area behind Big Y near the telecom tower, and the bridge over West Street. There are also unpermitted junkyards within the upper portions of the watershed. Unauthorized storage of vehicles and equipment at these locations could lead to pollution from leaks or spills.

The former Ware Farm Equipment Company, located at 200 West Street, is 14-acre site that was contaminated with both hazardous material and petroleum substances. Approximately 5 to 7 acres of the property was also a solid waste disposal area that was last used in the mid-1920s and is now capped and inspected annually. Burning waste at the disposal site led to elevated concentrations of total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs) in the soil, groundwater and surface water. The parcel was subdivided in 2010 and 4.4 acres, where the old buildings were located, has been cleaned up and redeveloped into the town fire and rescue station.

A parcel of land on Sheehy Road was historically used as a dump for approximately one year. The DEP required site assessment and remediation, which has been completed with the installation of a cap in 2015. The site is located within the Zone II Groundwater Protection Area associated with Muddy Brook. Groundwater in this area contributes directly to the Town drinking water wells.

PROPOSED LANDFILL EXPANSION IN HARDWICK

On July 18, 2023 Casella Waste Systems Inc. proposed to the Hardwick Select Board their plans to reopen the Hardwick Landfill by 2028 should the company secure needed permits and obtain zoning approval. During the meeting, Brian G. Oliver, region vice president for Casella, told the Board that the company envisions a 38-acre footprint at its Patrill Hollow Road location. The plan includes the site accepting on average 1,125 tons of waste per day. That would include household trash, municipal solid waste and construction and demolition debris. Combined, the annual total of waste would be about 350,000 tons.

The proposed reopening of the Casella Landfill in Hardwick would allow for uses that could dramatically affect the health, safety and welfare of the residents of Ware and Hardwick. The proposed landfill and subsequent use are located in the Zone 3 of the Town of Ware's drinking water supply aquifer and. While the Zone 3 area does not directly recharge water to the aquifer, it does drain to the Zone 2 area located just south of Hardwick Pond. The Zone 2 is the recharge area for the aquifer that is Ware's source of drinking water. The possibility of contamination of the water increases with an industrial use in this rural location. Sixty-five percent (65%) of Ware's residents depend on this aquifer for drinking water. Additionally, diesel exhaust and emissions related to the increased truck traffic in the area, road damage and potential surface water contamination of Muddy Brook from the transport and from the landfill itself are very concerning. As the capped landfill directly abuts Muddy Brook the negative environmental impacts of the proposal will be detrimental for the Watershed. Industrial uses will contribute to the warming of a state designated Cold-Water fisheries resource and potential leachate contamination along Muddy Brook including Hardwick Pond.

TRANSPORTATION CORRIDORS

The major transportation corridors located in the Muddy Brook Watershed include Route 9 & Route 32, both of which cross Muddy Brook and have point source discharges to Muddy Brook from roadway drainage infrastructure. Route 9 is the major east-west connector, running from downtown Ware east to the City of Worcester and west to the Town of Amherst and City of Northampton (where I-91 can be accessed). Route 32 runs northeast to southwest, following the Ware River through town. Route 32 has become a magnet for more recent commercial development, including "strip mall" development. Beyond Ware, Route 32 extends into Palmer where the Massachusetts Turnpike can be accessed. Pedestrian facilities in Ware are concentrated in the more densely developed areas of downtown and extending south on Route 32 to Ware Junior/Senior High School. It is important to note, both Route 9 and Route 32 have bridges that cross Muddy Brook in the downtown area.

A significant amount of high-density residential streets in and around the downtown area are located within the Muddy Brook Watershed. Local streets within the Muddy Brook Watershed were identified as having stormwater flooding issues during and after large rainfall events. The Working Group identified a local street near the United Church of Ware as "Water Street" due to the frequency of flooding at this location. Additionally, many stormwater systems and road-stream crossings are undersized relative to current and future rainfall in the region, leading to additional stormwater flooding, erosion, and water quality concerns. Catch basins transport stormwater from roadways and adjacent properties to the ground, streams, rivers or reservoirs. As flowing stormwater travels, it picks up de-icing materials, petroleum chemicals and other debris on roads and contaminants from streets and lawns. Common potential contaminants in stormwater originate from automotive leaks, automobile maintenance and car washing, or accidental spills.

The roads north of Snow Pond take on the traditional characteristics of a typical rural New England town. Drainage transfers from pipes and outfalls to traditional country drainage – where water sheet flows off the road to vegetated or rock swales. The Working Group identified this as a problem, especially on Sorel Road & Greenwich Road which are graded toward Muddy Brook. Dumping is also very common on remote roadways, as these are frequent sites for illegal dumping of hazardous and other potentially harmful waste that pose a significant threat to the water supply and roadways.

ROAD-STREAM CROSSINGS AND CULVERTS

The four major road crossings over Muddy Brook are bridges, which are considered adequate when assessed for stream continuity purposes as they typically span bank to bank. Culverts on tributaries to Muddy Brook have not officially been assessed. Based on preliminary field surveys many of the culverts located within the Muddy Brook watershed are undersized, poorly positioned, and several have perched outlets that create significant barriers to fish and wildlife migration. Upgrading the stream crossings on tributaries to Muddy Brook is critical to providing navigable pathways for trout, other aquatic organisms and terrestrial species.

By upgrading and installing a well-designed crossing with an open bottom the Town will see multiple environmental, social and economic benefits. Re-establishing the natural stream channel with natural substrates and spanning bank to bank will allow natural stream processes to reoccur. Ensuring passage within the culvert for fish and wildlife as well as creating good habitat for stream dwelling animals will increase biodiversity within the

watershed. Also, as the climate changes, many organisms depend upon access to cooler upstream habitat to survive and reproduce so upgrading road-stream crossing as well as improving the stormwater infrastructure associated with roadways will mitigate against climate change impacts.

The economic and community benefits of upgrading culverts include reduced maintenance costs, decreased probability of flood-related damage, increased project lifetime, and reduced road user costs. An upgraded crossing will reduce the likelihood of a catastrophic failure of the existing crossing. Studies have shown that on average, upgrades to culverts are 38 percent less expensive than in-kind replacement and maintenance over 30 years. These savings are substantial in a low-income community such as Ware.

The reduced risk of area flooding generates a variety of positive social and economic outcomes, including avoiding road closures and associated travel delays. In addition, reduced flood risk to area residential properties potentially increases property values. Also improved stream habitat for recreationally valuable species, as well as improved conditions for recreational angling may attract additional recreational activity at or near these sites. Recreational benefits may also accrue up the food chain due to improved habitat conditions for recreationally valuable terrestrial species that rely on the fish and other riverine species as a food source. Increased recreational activity can stimulate regional economies (e.g., promoting business expansion through trip-related expenditures).

DRAINAGE INFRASTRUCTURE WITHIN THE MUDDY BROOK WATERSHED

The Ware Department of Public Works (DPW) is responsible for the public storm drainage system, which includes catch basins, drain manholes, pipes and culverts. The Town of Ware is not a regulated Small Municipal Separate Storm Sewer System (MS4) under the US Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) Permit, and therefore does not currently have a public outreach and education program or illicit discharge detection and elimination program in place. The DPW also does not have a program to map stormwater infrastructure town-wide or to develop a more systematic approach to operation and maintenance, both of which are important best management practices for reducing stormwater pollution.

PUBLIC WATER SUPPLIES AND AQUIFERS (MAP 9)

An aquifer is defined as an underground water-bearing layer of permeable material that will yield water in a usable quantity to a well. The Town's drinking water wells have designated Zone I and Zone II areas to protect the area closest to the wells and the primary recharge area for the aquifer, respectively. Seventy percent of Ware's population is served by a public water supply and the remainder draw from private wells. The most important and largest aquifer in Ware is Muddy Brook and is designated as a Zone II protection area by DEP. Zone II is the primary recharge area for the aquifer. This area is defined by hydrogeologic studies that must be approved by DEP. The Zone II area (# 490) for the wells located in Muddy Brook valley is 55% forest, water or wetland, with the remaining area a mix of low to high density residential land use (22%), a few commercial activities and agricultural activities. The most densely developed southern portion of Zone II near the wells in the Muddy Brook valley is served by municipal sewer. However, the area immediately upgradient of the Snow Pond Well (04G) is not served by municipal sewer. Various development and use restrictions exist in these zones to protect both water quality and potable water availability for the town.

As previously stated, the most important and largest aquifer in Ware runs along Muddy Brook and Greenwich Road down to Snow Pond, and it supplies four wells and a cistern west of Barnes Street. Each well has its own pump station and treatment facilities. Wells 1/2/3 (01G) is a set of three, 8 x 18-inch diameter, gravel packed wells originally installed in 1978 to replace a shallow tubular wellfield just north of Pines Pond. Well #4, Snow Pond Well (02G), is an 18 x 24-inch diameter, gravel packed well located just north of Pines Pond and just south of Snow Pond. In 2015, the three (3) wells at the Barnes Street site were replaced with new gravel-packed wells. Drinking water is transported from these locations through town via 40 miles of water main. The system includes two standpipes (holding tanks), located at Church Street and Anderson Road. The wells have a daily capacity of 1.8 million gallons, and the town's average daily demand is 1.2 million gallons per day. The system can meet the average water demands of the present population.

The overall ranking of susceptibility to contamination for the entire system is high, based on the presence of at least one high threat land use within the water supply protection areas. The MA Drinking Water Regulation, found at 310 CMR 22.00 requires public water suppliers to own the Zone I, or control the Zone I through a conservation restriction. Activities other than those directly related to the public water supply are prohibited within Zone I. Zone I for the water supply wells is a 400-foot radial area around each of the wellheads. According to DEP Source Water Assessment and Protection (SWAP) Report for Ware Water Department Zone I is considered non-conforming under these regulations because they contain non-water supply activities including homes and public roads. The wells in the Muddy Brook valley are also non-conforming, with residential and recreational land uses in Zone I. The following non-conforming activities are located within the Zone I of the wells:

Wells #1, 2 and 3 (01G) - Wells #1, 2 and 3 (source 01G) are located within a residential area of town. A portion of Pleasant Street, two homes and portions of two other lots are located within Zone I of source 01G; the three lots with homes are served by Town sewer and water. There is also a town baseball field within Zone I; parking occurs within Zone I during events at the field.

Well #4 (02G) - Well #4 is located north of the source 01G (Wells 1, 2 and 3). A portion of Pleasant Street, two homes (one served by a private septic system, and one served by Town sewer system) are located within Zone I.

Cistern (04G) - The Cistern (04G) is located south of source 01G. The baseball field and parking area, the Water Department's motor control building (old pumping station), the storage (maintenance) garage and residential backyards are within Zone I of the Cistern. The motor control building has secondary containment for petroleum products stored on site.

The proximity of recreational, residential and commercial activities that utilize on-site septic disposal systems was identified as a top concern for the Working Group and identified as the greatest threat to the public water supply sources. Nutrient pollution in ground water was a close second, as nutrients can be harmful, even at low levels. Infants are vulnerable to a nitrogen-based compound called nitrates in drinking water. Excess nitrogen in the atmosphere can produce pollutants such as ammonia and ozone, which can impair our ability to breathe, limit visibility and alter plant growth. When excess nitrogen comes back to earth from the atmosphere, it can harm the health of forests, soil and waterways. Other land uses and activities within the Muddy Brook Watershed identified as potential sources of contamination to Zone II are:

- landfills;

- contaminated sites (such as Brownfields sites or Superfund sites);
- oil and gas storage facilities or underground storage tanks;
- industrial and municipal wastewater outfalls (such as those addressed by the National Pollutant Discharge Elimination System (NPDES) permit program);
- gravel mining operations;
- agriculture and other types of nonpoint sources of pollution;
- stormwater runoff from streets and lawns (and other nonpoint sources in urban areas);
- industrial and commercial facilities that use or store chemicals (such as automotive body shops, dry cleaners, and others reported to the Toxic Release Inventory (TRI) program);
- cemeteries; and
- roads and hazardous materials transportation routes.

SIGNIFICANT HAZARD DAMS

There are three dams located withing the Muddy Brook Watershed. Two of the three dams are classified by the Office of Dam Safety as Significant Hazard Dams. This means the dams are located where failure or improper operation may cause loss of life and damage to homes, industrial or commercial facilities, secondary highways or railroads or cause interruption of use or service of relatively important facilities. Snow Pond Dam is one of the Significant Hazard Dams in the watershed and exists primarily for “recreations” as stated in a 2021 Dam Safety Report.

The Snow Pond Dam is located on Muddy Brook in the Town of Ware, in Hampshire County. The Dam location is shown on the North Brookfield USGS quadrangle map at coordinates 42.26654, -72.24679. Access to the dam is from Pleasant Street. The total drainage area contributing to Snow Pond is about 19 square miles. The Dam is a 400-foot-long earthen dam with a maximum height of 15 feet. The dam crest is covered with well-maintained grass to the right of the spillway. Most of the crest on the left embankment is topped with crushed stone. The crest measures approximately 25 feet wide immediately to the right and left of the spillway. The crest width along the remainder of the embankment is about nine feet.

The embankments are faced with concrete walls on the upstream side adjacent to the spillway. Opposite the concrete walls, on the downstream side, are stone masonry walls. The remainder of the embankment to the right is covered with grass, upstream and down. The upstream slope on the left side is covered with machine placed riprap. The downstream slope is grass covered.

As part of the reconstruction work completed in 2002, the 130-foot embankment to the left of the spillway was armored with riprap along its upstream and downstream slopes to minimize damage in the event of an overtopping. A concrete core wall also extends from the spillway to the left abutment. The top of the core wall is approximately one foot below the crest elevation. Topsoil was placed over the riprap on the downstream slope so that a grass surface could be established. Gravel and small stone were placed on the dam crest along the left side.

The right embankment is 230 feet long and has a curved horizontal alignment along the middle of the embankment. The height of the embankment between the curved section and the right abutment is only about 3-feet. The spillway is a concrete ogee weir, 42 feet. long, with stone masonry training walls that have been faced

with concrete. The training walls were extended with short concrete wall sections on the downstream side of the spillway, constructed at the time of the 2002 repairs. The discharge channel is lined with riprap for erosion control and transitions to a natural stream channel that passes approximately 100 feet downstream under the Pleasant Street bridge. A drop inlet structure to the right of the spillway serves as a low-level outlet. Discharge through the concrete structure is controlled by stop logs in the upstream face. A bar rack is mounted on the upstream face of the structure and grating is mounted on the top of the structure. A 54-inch reinforced concrete pipe (RCP) exits the downstream face of the structure and discharges to the riprapped slope of the downstream channel.

Snow Pond Dam has a maximum storage capacity of 625 acre-feet. In accordance with Department of Conservation and Recreation (DCR) classification, under Commonwealth of Massachusetts Regulations 302 CMR 10.00 Dam Safety revised November 4, 2005, Snow Pond Dam is an Intermediate size. The area consists of rolling terrain that is mostly undeveloped. It appears that failure of the dam at maximum pool may cause damage to public facilities and private property with the possibility of loss of life. Under the same DCR classification procedures, Snow Pond Dam is classified as a Significant (Class II) Hazard Potential Dam. The Hazard Potential Classification recommendation is consistent with the Hazard Potential Classification on record with the Office of Dam Safety. Based on the Class II classification, the regulations require Snow Pond Dam to be inspected at five years intervals.

LEEVES

The current levee system was constructed as a result of the Flood Control Act of 1938, which authorized flood control projects to be constructed by the United States Army Corps of Engineers (US ACE). The levees were constructed in 1960, using climate data from that time. Levees were constructed to withstand a 100-year storm (a storm with a one percent chance of occurring in any given year) or 500-year storm (a storm with a 0.2% chance of occurring in any given year). However, the severity of a 100-year and 500-year storm has increased significantly due to climate change rainfalls, meaning that the chance that levees will be breached or overtaken by flood waters has also increased. The US Army Corps of Engineers (ACE) regularly inspects all levees in the country, through the National Levee Database. There are three levees in the Ware, two of which are associated with Muddy Brook. Both levees were built in 1960 and were last inspected on April 27, 2023. One levee is 0.02 miles in length and is rated as Minimally Acceptable, the other is 0.19 miles in length and is rated as acceptable. Key steps communities can take (many of which Ware has) to manage levee-related risk include:

PUBLIC OUTREACH AND EDUCATION

- Educate property owners living and working near levees about levee-related flood risk.
- Encourage property owners to reduce the financial risk related to flooding by purchasing flood insurance (see FEMA's Levees and Flood Insurance Fact Sheet).
- Encourage residents to seek information about what additional steps they can take to protect their families, homes, and possessions. To learn more, check out FEMA's Homeowner's Guide to Retrofitting.

FLOODPLAIN MANAGEMENT

- Maintain and enforce floodplain permitting for development in the floodplain and the floodway.
- Consider if development behind levees is in the best long-term interest of the community and how to put standards in place to protect against future flooding.

- Acquire property and relocate structures behind levees to return those areas to green space.
- Remodel or retrofit buildings behind the levee to be floodproof, such as by elevating structures above the flood level.
- Avoid building structures, planting trees, or leaving debris on or near the levee that could impede proper operation and maintenance.

EMERGENCY PREPAREDNESS

- Plan and practice emergency response and evacuations. If floodwaters are advancing on a levee, at what point should residents begin evacuating? If there is a levee failure, what are the safest travel modes and routes out of the flooded area?
- Encourage residents to visit Ready.gov to learn how to make an emergency plan.

PARTICIPATION IN FEMA PROGRAMS

- Participate in FEMA's Community Rating System, an incentive program that recognizes communities for additional efforts they take beyond the minimum NFIP standards to reduce the impacts of flooding. Communities that show a comprehensive approach to floodplain management can gain a reduction in flood insurance premium rates of up to 45 percent.
- Apply for Hazard Mitigation Grants as appropriate to help fund projects to reduce hazard related losses both before and after a disaster event.

PLANNING

- Identify what local planning vehicle is the most appropriate for addressing levee-related flood risk and mitigation priorities. Does your community have a local hazard mitigation plan? Or a capital, comprehensive, continuity of operations, and/or stormwater plan?
- Use best available flood risk data (available for community use from FEMA) to inform local planning for mitigation.
- Encourage your local hazard mitigation planning team to include and prioritize mitigation actions for your community's levee.

POINT AND NON-POINT SOURCE POLLUTION

POINT SOURCE POLLUTION

The U.S. Environmental Protection Agency (EPA) defines point source pollution as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack." Factories, sewage treatment plants and separate municipal stormwater systems are three common types of point sources. Factories, including oil refineries, pulp and paper mills, and chemical, electronics and automobile manufacturers, typically discharge one or more pollutants in their discharged waters (called effluents). Some factories discharge their effluents directly into a waterbody. Others treat it themselves before it is released, and still others send their waste to sewage treatment plants for treatment. Sewage treatment plants treat human waste and send the treated effluent to a stream or river. Discharge from separate municipal storm drain systems is also considered point source discharge, even though the true source of stormwater pollution can be traced to runoff across the land surface. This is largely due to the grey infrastructure traditionally used for stormwater management by cities

and towns. Grey infrastructure is the connection of catch basins, drains, pipes, ditches, swales, culverts, and outfalls meant to slow the flow of stormwater during rain events to prevent flooding. Often the grey stormwater infrastructure's outfall is directly into a waterway – making it a point source pollutant.

Unregulated discharges from point sources can result in water pollution and unsafe drinking water and can restrict activities like fishing and swimming. Some of the chemicals discharged by point sources are harmless, but others are toxic to people and wildlife. Whether a discharged chemical is harmful to the aquatic environment depends on several factors, including the type of chemical, its concentration, the timing of its release, weather conditions, and the organisms living in the area.

The Working Group was not aware of any point source pollution locations within the watershed. As many of the roads, houses, and farms were constructed in the mid-1900s, and Ware is not a MS4 community, a future field investigation may find undocumented point source discharges that could benefit from treatment.

STORMWATER RUNOFF

Stormwater runoff is defined as rainwater or snow that is not absorbed into the ground, instead traveling overland until it is collected by the municipal stormwater system or is carried into a wetland or waterbody. EPA studies have demonstrated that stormwater pollution is one of the most significant sources of water pollution today. When it rains or snow melts the resulting stormwater picks up or dissolves pollutants and washes them into stormwater conveyance systems. Polluted stormwater runoff is often discharged into local rivers and streams without treatment. Common pollutants include oil, grease and metals from cars and roadways; pesticides and fertilizers from lawn maintenance activities; sediment from construction sites; and the improper disposal of litter including cigarette butts, paper wrappers and plastic bottles. Stormwater can impair waterways, degrade animal habitat, pollute drinking water, increase flooding, cause erosion of streambeds or siltation of waterways, and decrease the amount of water recharged to aquifers.

Stormwater runoff is often worsened by human activities and increased development. Urban and suburban areas produce much more stormwater runoff due to the high amount of paved and hard surfaces because stormwater flows over hard surfaces directly into a water body or storm drain, there is no opportunity for soil and plants or a water treatment facility to filter out pollutants Residents and businesses can play a major role in the reduction of stormwater impacts to surface water bodies. When residents and businesses are provided with the appropriate information, they can better understand the effects of illegal discharges and the improper disposal of waste.

Stormwater was identified by the Working Group as a significant concern for the Muddy Brook watershed area, and an opportunity to connect with residents on methods for reducing stormwater flows and pollution from their property through public outreach and education. The area of Town most affected by stormwater includes the entire easter urbanized area of the Muddy Brook Watershed. Significant flooding has occurred in the areas of Church Street to Aspen Street, and in the apartment complexes of both Highland and Hillside Village.

NUTRIENT POLLUTION

One of America's most widespread, costly and challenging environmental problems is nutrient pollution caused by excess nitrogen and phosphorus in stormwater. Nitrogen and phosphorus are nutrients that are natural parts of aquatic ecosystems. Nitrogen is also the most abundant element in the air we breathe. Nitrogen and phosphorus support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish and smaller organisms that live in water. When too much nitrogen and phosphorus enter the environment, usually from a wide range of human activities, the air and water can become polluted. Nutrient pollution has impacted many streams, rivers, lakes, bays and coastal waters for the past several decades, resulting in serious environmental and human health issues, and impacting the economy.[2]

Too much nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms. They can severely reduce or eliminate oxygen in the water, leading to illnesses and the death of large numbers of fish. Some algal blooms are harmful to humans because they produce toxins and bacterial growth. People can become sick if they are exposed to polluted water, consume tainted fish or shellfish, or drink contaminated water. This can clearly be seen in Snow Pond, as the lack of any stormwater management around the pond is resulting in alga blooms and severely degraded water quality.

PESTICIDE, HERBICIDE AND FERTILIZER USE

Pesticide, herbicide and fertilizer use is a current and future threat to the health of the Muddy Brook Watershed. These chemicals are applied to lawns of residential and commercial properties, picked up by stormwater or absorbed into groundwater, potentially contaminating the Brook and aquifer. Fertilizers can lead to excessive and harmful algal growth in bodies of water comparable to Snow Pond and decrease both the health and recreational usability of the waterbody.

The Commonwealth of Massachusetts has a stringent program for registration of pesticides and certification of those authorized to apply them. Once a pesticide has been approved for use by the USEPA, it must be registered by the Massachusetts Pesticide Board Subcommittee prior to being distributed, purchased, or used in Massachusetts. Pesticide classification in Massachusetts is based on the potential adverse effects the pesticide may have on humans or the environment. “Restricted Use” pesticides can only be sold by Licensed Dealers to Certified Applicators, while “State Limited Use” pesticides may be restricted to use by certain individuals or require written permission from the Department of Agricultural Resources prior to use. Legal application of pesticides must be performed by an individual licensed or certified by the Massachusetts Department of Agricultural Resources. A Commercial Applicator License is required for applying general use pesticides, and a Commercial Applicator Certification is required for applying restricted and state limited use products.

[2] https://www.epa.gov/nutrientpollution/issue

Right-of-way maintenance can also be a source of contamination. National Grid power lines cross from Old Gilbertville Road to Greenwich Road. Herbicides are used annually as part of their Vegetation Management Plan (VMP).

SEWER AND SEPTIC SYSTEM FAILURE

The Town has municipal sewer that services the urbanized areas of Town. The Town's wastewater treatment plant and collection system need significant work and upgrades. The collection system is comprised of approximately 32 miles of gravity sewer mains and one small pump station serving approximately 1,548 accounts. This system services approximately 55 percent of town residents and several industries. The remainder of the town utilizes on on-site septic systems. The most densely developed southern portion of the Muddy Brook valley is served by municipal sewers. However, the area immediately north of the Snow Pond Well is not sewered.

As previously stated, the Muddy Brook watershed north of Snow Pond is outside of the municipal sewer service area and relies on on-site septic systems for wastewater disposal. On-site septic systems utilize leach fields to treat wastewater prior to recharge into the water table and aquifer. These systems require appropriate subsurface or above grade materials with specific permeability rates and adequate separation to seasonal high groundwater levels in order to provide sufficient treatment. The useful lifespan of an on-site septic system depends on the type of system used and its level of maintenance but is typically about 25-30 years. Ware has many areas of poorly draining soils, and consequently proper on-site sewage disposal is a challenge.

When on-site septic systems reach the end of their useful lifespan, the wastewater disposed into the system is no longer adequately treated, and can present a hazard to groundwater quality, human health, and environmental health. If the system's leach field no longer has adequate pore space, the untreated wastewater will break through at the ground surface or back-up into the residence. Occasionally, failure of on-site septic systems will go unnoticed if the system is directly discharging untreated wastewater into the groundwater without causing a breakout at the ground surface or back-up into the structure.

Septic systems allow treated wastewater effluent, which is rich in phosphorus and other nutrient content, to leach into the groundwater and potentially migrate to Snow Pond. Because phosphorus tends to bind to soil particles, the distance it can travel may be relatively short. For this reason, it is recommended to assess septic systems within 200 feet of Muddy Brook and its tributaries to determine the annual septic system phosphorus load. Although investigating the specific ages and types of construction of on-site septic systems thorough town records within the Muddy Brook Watershed is outside the scope of this plan, based on the overall age of residential structures and subdivisions within the watershed area, the Working Group expects that many of the on-site septic systems within the area are at or close to the end of their useful life.

HABITAT LOSS

COLDWATER FISHERIES RESOURCES

Muddy Brook is a designated cold-water fisheries resource. Brook Trout are abundant in the stream and require access to cool headwater tributaries for survival. Coldwater tributaries are also very important in helping maintain

the cold-water status of their receiving waters and are highly susceptible to changes in water quality and/or quantity such as siltation and run-off, water level fluctuations, loss of riparian habitat, stream fragmentation and alterations of the temperature regime. DEP's Stormwater Management Standards for critical areas such as cold-water fisheries resources and Zone II's to Public Water Supply areas require BMPs that assure no untreated or warmwater runoff from impervious surfaces directly enters these resources. Recent studies have shown that stormwater BMPs allow standing, surface water function as "heat sinks" in summer and lose heat in winter.

Untreated stormwater discharges to the stream add warm, untreated water directly into Muddy Brook. By upgrading the crossings and improving stormwater management along the roadways to stop the direct discharge of untreated and warm-water runoff from impervious surfaces from directly entering the stream will increase the ability of the brook to support cold-water fish species. Ideally, removing any point source discharges and incorporating into future crossing designs a chain of cold-water BMPs with deep infiltration and filtration capabilities to cool the stormwater to ground temperature in both summer and winter will provide the most effective long-term protection of the cold-water resources and will directly lead to healthier fish populations and improved water quality.

STREAM FRAGMENTATION AND FLOW ALTERATION

Maintaining the integrity of river and stream ecosystems is critical to aquatic organism and wildlife passage and climate resilience, as these resources provide buffering from extreme weather events and strengthen habitat connectivity allowing aquatic species to move within a watershed as they adapt to changing climatic conditions. Preserving aquatic connectivity under these conditions is critical for maintaining long-term ecosystem health and processes because as barriers like dams, bridges, culverts, and road crossings, often lead to ecosystem fragmentation, decreased organism mobility, and the disruption of key ecosystem functions.

CLIMATE CHANGE

Climate Change is the overarching threat to the health of the Muddy Brook Watershed as identified by the Working Group. Losses to aquatic biodiversity occur at a rate five times faster than they do on land. This accelerated rate of loss is a result of a variety of stressors that are amplified in aquatic habitats, including climate change. Climate change affects the structure and function of aquatic ecosystems both directly and indirectly. Direct effects include increases in water temperatures and changes to hydrology, while indirect effects may alter plant and animal communities, and accelerate the spread of invasive species. Aquatic habitats are particularly susceptible to these changes because habitat conditions like water temperature and the amount of water are climate-dependent, species that inhabit them are less able to disperse, and multiple stressors are already impacting them. These additional stressors, affecting many of Massachusetts' freshwater habitats, include adverse effects from past timber harvest, spread of invasive species, urbanization, flow alteration, pollution, and damming, often amplified by climate change. In some cases, multiple historic events have led to the degradation of habitats in the same waterbody. Located at the lowest elevations, freshwater habitats are susceptible to these activities occurring on upstream and upslope portions of their landscapes.

Conservation actions to protect or restore freshwater habitats can help address these threats. For example, areas with high native species biodiversity are assumed to be more intact and are therefore often prioritized for land

acquisition. Landscape level planning can inform freshwater conservation at the site scale and can incorporate the link between freshwater and terrestrial systems across large landscapes. Dam removal, culvert upgrades, eradication of invasive species, daylighting of streams and floodplains, removal of channelization structures, and upslope revegetation are all examples of management actions that can be used to improve conditions in freshwater habitats.

The Climate Change Clearinghouse for the Commonwealth provides climate projections downscaled to watershed basins[3], based on data from the Intergovernmental Panel on Climate Change (IPCC) 5th report and modeled by the Northeast Climate Adaptation Science Center based on a high and medium carbon emissions pathway. Ware is located within the Chicopee River Basin, which is projected to see the following changes from the baseline levels observed between 1971 and 2000 by the end of the century (2090):

- Annual precipitation: 3.55 to 5.58 inch increase from the baseline of 46.64 inches;
- Average temperature: 5.13 to 9.47 degrees hotter than the baseline of 46.16 degrees Fahrenheit;
- Days over 90 degrees Fahrenheit: 19.3 to 58.8 days more than the baseline of 3.35 days; and
- Days below 32 degrees Fahrenheit: 28.93 to 53.04 days less than the baseline of 161.76 days

The increase in precipitation is expected to impact overland flooding, riverine flooding, road-stream crossings, streambank erosion, functionality of on-site septic systems, functionality of stormwater treatment systems, and stream temperature. The increase in average temperature and days over 90 degrees Fahrenheit is expected to result in increased algal growth, increased need for recreational opportunities related to cooling, and impacts on habitat and increased invasive species. Similarly, the loss in days below 32 degrees Fahrenheit is expected to result in more winter precipitation occurring as rainfall, which will lead to the need for application of more deicing materials, more erosion of road materials and stream banks due to increased freeze-thaw cycles, and changes in invasive insect species longevity.

INVASIVE SPECIES

Invasive species are an increasing threat to the health of the Muddy Brook Watershed both in terms of habitat loss and protection of the drinking water recharge area. Invasive species are defined as species that are not native to the local ecosystem and have the potential to outcompete beneficial local species. Invasive plant species are problematic because they do not provide food and habitat to native animal and insect species as beneficial indigenous plants do and may not provide additional benefits such as erosion control. Similarly, invasive insect species are a concern due to their potential negative impact on trees and native plant species that provide habitat, food, and erosion control within the watershed.

The Massachusetts Invasive Plant Advisory Group (MIPAG) maintains a list of invasive plant species in Massachusetts[4]. During discussion with the Working Group, it was noted that multiflora rose, and bittersweet

[3] https://resilientma.mass.gov/map/

[4] https://www.mass.gov/service-details/invasive-plants

have been identified within the East Quabbin Land Trust's (EQLT) property on Muddy Brook. Snow Pond is riddled with invasive species such as Eurasian milfoil and fanwort. Purple Loosestrife, Japanese Knotweed, Garlic Mustard, Oriental Bittersweet, Japanese Barberry, Japanese Honeysuckle, and Multiflora Rose were all observed just along the banks of Muddy Brook south of the North Street Bridge until its confluence with the Ware River.

The presence of invasive species is anticipated to increase with increasing temperatures and precipitation due to climate change and is expected to detrimentally impact the health of the forests and riparian areas within the watershed. The presence or absence of invasive insect species such including, but not limited to Spongy Moth or Emerald Ash Borer, both of which can lead to significant tree loss, is currently unknown, but was flagged by the Working Group as a potential future concern.

RIVERBANK EROSION/LOSS OF RIPARIAN BUFFER

The USDA Forest Service defines the riparian buffer as *"an area adjacent to a stream, lake, or wetland that contains a combination of trees, shrubs, and/or other perennial plants*." Buffers provide numerous benefits to streams, including the filtering of nutrients, pesticides, and animal waste from agricultural runoff, stabilizing eroding banks, providing shade, shelter, and food for aquatic and terrestrial organisms, and protecting adjacent properties from flood damage.[5]

The overall state of the riparian buffer throughout the Muddy Brook Watershed was not known by the Working Group but is expected to be comprised or non-existent in the downtown and urban areas, and at risk near the large agricultural operation in the northern part of the watershed. Similarly, the banks of Muddy Brook near the confluence with the Ware River downtown are eroding. Protection of the riparian buffer of Muddy Brook is of particular importance in maintaining the Coldwater fisheries habitat and high-water quality required to sustain the rare and endangered species that currently thrive in Muddy Brook. The Working Group identified an opportunity to coordinate with the large agricultural operation for potential restoration and protection of the riparian buffer. This work could potentially be funded through a grant from the Natural Resources Conservation Service (NRCS).

[5] https://www.fs.usda.gov/nac/practices/riparian-forest-buffers.php

CHAPTER 4: STRATEGIES AND ACTIONS TO INCREASE RESILIENCE

INTRODUCTION

This chapter will identify opportunities the Town implement take to reduce risks and increase resilience from the hazard and climate vulnerabilities and consequences identified in the previous chapter. Opportunities include the installation of green infrastructure on Town owned land, opportunities for redevelopment in the urbanized area of the Muddy Brook Watershed, land conservation strategies and priorities to connect resilient lands and protect land within the Zone II aquifer protection zone, the removal of the two dams on Snow Pond, and the corresponding restoration of Muddy Brook.

COMMUNITY BENEFITS OF GREEN INFRASTRUCTURE

Green Infrastructure (GI) strategies serve multiple functions including cooling and beautifying streets and creating wildlife habitat. Green Infrastructure is also good for people, as a successful project can increase community engagement, create green jobs, and help neighborhoods deal with the impacts of climate change. Key co-benefits include:

- Improved Quality of Life: Studies indicate that green space enhances a sense of well-being. Exposure to nature reduces mental fatigue and has a rejuvenating effect. Green Infrastructure also helps to create a more pedestrian-friendly environment that encourages walking and physical activity, improving overall health.
- Reduced Heat Island: Green Infrastructure has been shown to decrease localized and overall urban temperatures, often referred to as the urban heat island effect. Hard surfaces, like pavement and roofs, retain and radiate heat. Natural surfaces, like tree canopy and other types of vegetation, absorb heat and convert it to energy so that plants can grow. Vegetation also creates shade, which reduces overall temperatures.
- Improved Air Quality: Vegetated GI features reduce smog by lowering air temperatures and the need for air conditioning. Vegetation can also reduce particulate pollution by absorbing and filtering the tiny bits of dust, chemicals, and metals suspended in the air.
- Community Involvement: Successful GI implementation requires a multidisciplinary and inclusive planning and design process that includes residents, neighborhoods, businesses, and institutions such as schools and churches. Involving the community through volunteer workshops, tree plantings, and even GI construction are fun and educational efforts that help build community connections.
- Job Creation: Green Infrastructure implementation creates green jobs in design, construction, and maintenance, especially programs that include a Green Jobs Training Program to train workers to build and maintain features. Underserved groups in urban areas benefit immensely from these programs, as the green jobs field continues to grow.
- Reduced Energy Costs: Trees and vegetative cover can lower ambient air temperatures in urban areas through shading, windbreak, and evapotranspiration, lowering demand for the energy needed to provide air conditioning. Green roofs also insulate against extensive heat loss in the winter and heat absorption in the summer.

- Carbon Sequestration: While studies are still being conducted to quantify the amount of carbon that GI sequesters, healthy soils and vegetation have the potential to pull carbon dioxide from the atmosphere, helping to offset greenhouse gas emissions. Habitat Improvement Even small patches of vegetation provide habitat for birds, mammals, amphibians, reptiles, and insects. By reducing erosion and sedimentation, GI also improves habitat in small streams. Large-scale GI such as parks, vegetated wetlands, and urban forests help to facilitate wildlife movement between habitats.
- Increased Property Value: Many aspects of GI features can increase property values by improving aesthetics, drainage, and recreation opportunities that can help restore, revitalize, and encourage growth in economically distressed areas. Ensuring that GI strategies do not result in the displacement of low-income residents is critical to ensuring equitable access to GI benefits.

Green Infrastructure Co-Benefits: Co-benefits of different GI strategies. This matrix highlights the key co-benefits of different GI BMPs. Understanding how to maximize the benefits of your GI requirements can lead to a more successful project and create buy-in from multiple stakeholders.

OPPORTUNITIES FOR GREEN INFRASTRUCTURE INSTALLATION ON TOWN-OWNED PARCELS

Many passive and active recreational sites in Ware are located within the Muddy Brook Watershed close to the downtown area and within or close to the Environmental Justice area. This area is ideal for promoting low impact development and installing green infrastructure. By capturing rainfall close to where it falls, green infrastructure strategies reduce the impact of impervious surfaces, providing volume control and preventing the transport of urban runoff to rivers and streams. Instead, rainfall has a short journey to facilities that can help filter, absorb, or break down pollutants, either through proprietary devices or simply through microbial action in soils and plant roots. At the same time, the infiltration of stormwater into soils helps to recharge groundwater resources that are important to Ware for drinking water supply and are also essential to maintaining base flows for aquatic life in Muddy Brook and streams during the drier summer months.

Table 4.1: Town Owned Parcels with Potential for GI/LID

BMP Priority Ranking	Property Name	Address	Current Use	Map/Lot	Area (Acres)
1	The Pines, Kubinski Field, Reed Pool	22 Barnes Street	Recreation	60-0-70	26.6
2	The Pines	0 Pleasant Street	Recreation	62-0-45	3.1
3	Snow's Pond	0 Off Greenwich Road	Open Space	23-0-8	11.4
4	Aspen Grove Cemetery	99 Pleasant Street	Cemetery	60-0-72	31.2
5	Snow's Pond	0 Upper North Street	Open Space	29-0-67	3
6	Water Tank @ church Street	0 Old Gilbertville Road	PWS	23-0-13	11.5
7	The Pines	0 Eddy Street & 0 Pleasant Street	Recreation	60-0-177	5.6
8	Hyde Conservation Area	0 Old Stagecoach Road	Open Space	40-0-80	61.78
9	Snow's Pond Dam	0 Pleasant Street	Recreation	62-0-44	1.4
10	Snow's Pond Lakeview Park	0 Aspen Street	Recreation	63-0-45	3.2
11	Town Forest	0 Greenwich Road	Open Space	29-0-72	13.5
12	Finn Woodland	Old Gilbertville Rd	Open Space	40-36-1	37.82
13	Town Forest	0 Greenwich Road	Open Space	35-15-1	66.38
14	Old Sheehy Road Landfill	0 Sheehy Road	Open Space	29-48-1	5.27
15	Greenwich Road Drainage	Greenwich Road	Drainage	29-69-1	0.7
16	Gilbertville Road Slice	Gilbertville Road	Drainage	36-0-38	0.3
17	Greenwich Road Drainage	Greenwich Road	Drainage	63	0.6
18	Gilbertville Road Slice	Gilbertville Road	Drainage	64	0.3
TOTAL ACREAGE					**283.65**

PRIORITY SITES IDENTIFIED FOR THE INSTALLATION OF GREEN INFRASTRUCTURE (MAP 10)

THE PINES

The Pines is a large grass field with several located between Dora Street and Pleasant Street south of the Snow Pond Dam. It is currently mowed and maintained by the Town of Ware. Muddy Brook runs along the entire western side of the field. Runoff from the west side of Pleasant Street sheds off the shoulder and toward the grass field.

Photo 4-1: Dirt Access road from Dora Street.

Photo 4-2: Grassed area at the end of the dirt road and utility building.

A dirt road provides access to a utility building along the southern bank of Muddy Brook. This area is accessed via Dora Street to the south of the Snow Pond Dam. An existing concrete culvert provides foot access to the other side of Muddy Brook. The area surrounding the utility building is a grass and shows of sediment transport from the dirt road. Runoff from the road and surrounding area flows down the road and across the grass field before entering Muddy Brook. The bank of Muddy Brook in this area appears to be armored with stone. Improvements proposed include enhancing the natural buffer along the bank of Muddy Brook (approx. 500 square feet), installing a bioretention area at the end of the dirt road (approx. 1,250 square feet), and stabilizing the dirt road to prevent further erosion and sedimentation (approx. 6,000 square feet).

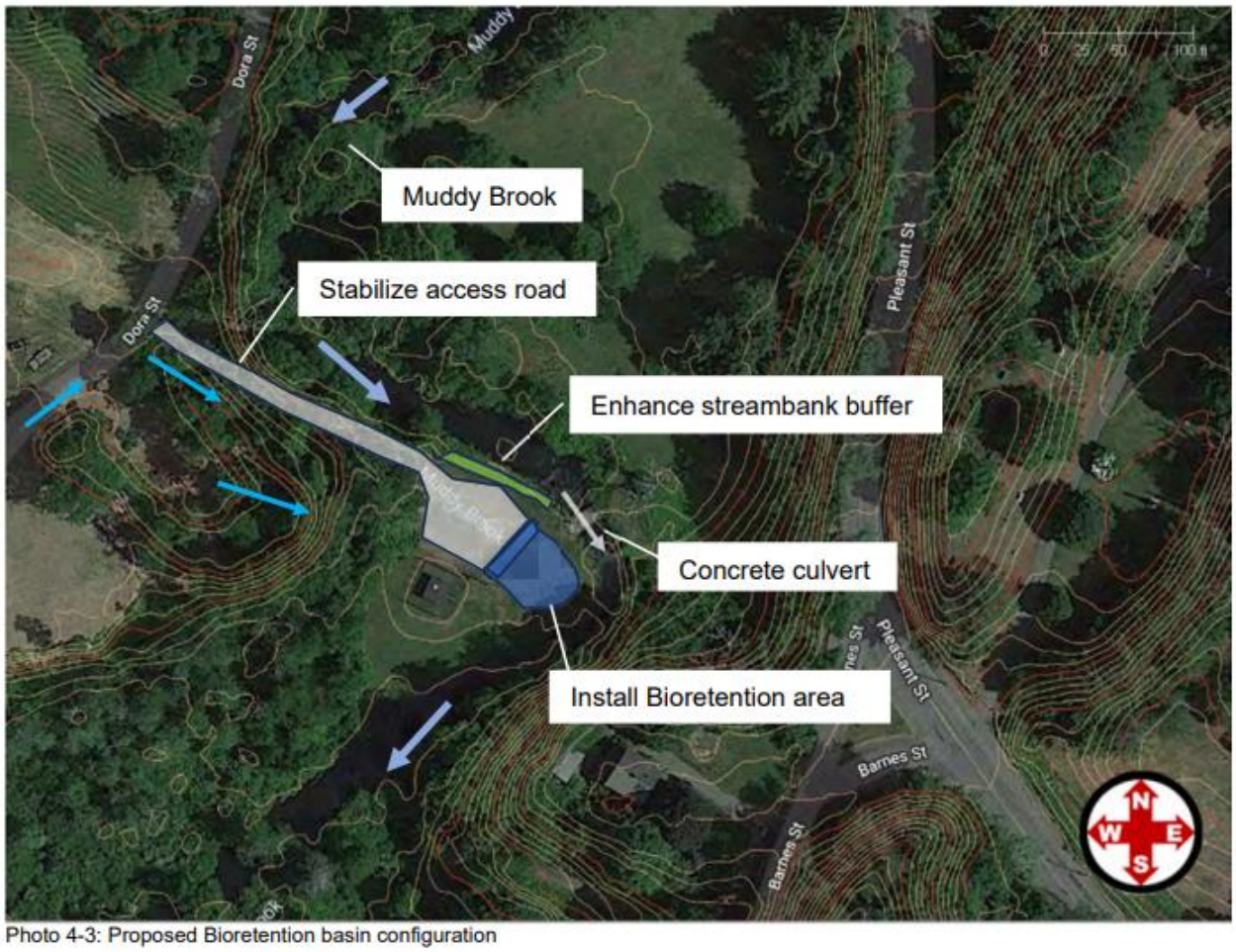


Photo 4-3: Proposed Bioretention basin configuration

REED POOL & BEAUREGARD MEMORIAL PLAYGROUND

The Beauregard Memorial Playground, also referred to as Ware Dreams Come True Park, is located at 119 West Main Street. There is a playground and picnic tables at this site. Reed Municipal Pool, also located at this site, was an outdoor pool opened during the summers. Reed Municipal Pool was closed by the Ware Parks Department after the 2018 season due to safety concerns. The Town held a series of "information gathering" sessions over the next two years with local stakeholders, boards, structural engineers, and contractors to determine a path forward. The Town also collaborated with local senators and representatives to identify available funding options.

Under the guidance of Representative Todd Smola, Ware received an Earmark Appropriation of $95,000 in 2021 Ware received an Earmark Appropriation of $95,000 for a Pool Study from the MA legislature. Under the guidance of Representative Todd Smola, the Pool Study was completed by AECOM to assess current conditions and determine the most efficient path forward. AECOM findings include:

- The existing concrete pool was originally completed in 1936 (88 years ago), with a capacity of 240,000 gallons. The filtration system was replaced most recently 15 years ago.
- The pool has challenges with high groundwater, the 12-foot depth is not needed for pool use and diving is not a required use. The new pool should have a maximum depth of six feet.

- The pool operated at a 125-person capacity, and the new pool will assume a similar capacity.
- A beach/ramp entry is a very desirable aspect of a new pool, for universal access.
- A new separate water spray pad is a desirable component of overall facility improvements.
- The existing bathhouse was evaluated as part of the 2022 MA Americans with Disabilities Act (ADA) planning grant and the Ware Transition Plan indicates areas to be improved to meet ADA requirements.
- The filter building needs ventilation improvements, equipment is subject to rapid corrosion.
- A bus turn-around should be part of the facility improvements, to support the collaboration with Highland/Hillside Village and Ware Public Schools anticipated use of the Quaboag Connector transportation system. The project will address the needs of Ware's most vulnerable populations; and consist of improvements to the entire Reed Pool Complex, and Quaboag Connector microtransit system.
- Demolish the existing swimming pool and replace it with a new pool in similar or exact location, with beach entry access to the pool from the shallow end.

The 2018 closure of the Reed Pool has upset many citizens and during the 2023 Open Space and Recreation Plan (OSRP) planning process the re-opening of the pool was strongly supported in both the public survey and community visioning session. The pool was identified as a top priority by many as important for recreation, safety (swimming lessons) and addressing the extreme heat climate risk facing Ware residents. Residents have overwhelmingly identified the inequality that the closing of the Reed Municipal Pool created in 2018 due to unsafe conditions. Residents, especially the children, realize the vital need for a new pool. Recently a middle school student wrote a letter to Stuart Beckley, Ware Town Manager, who identified her *"marvelous reasons*" why Ware needs to replace the current pool.

At the entrance of Reed Pool at the Ware Dreams Come True Park there is a large, grassed depression along the access road. The area currently receives runoff from the driveway and sheds east across the field to Muddy Brook. There was standing water at the northern end of the depression during the site visit. The driveway is currently in poor condition and is introducing sediment into the Brook via runoff. The Town mentioned plans to reconstruct the pool into a splash pad in the future, which would likely involve repaving the entrance road. This reconstruction provides a great opportunity to incorporate nature-based solutions and green infrastructure into the new site plan. These solutions include installing a gravel wetland with sediment forebay where the existing grass depression resides (approx. 12,000 square feet), re-route the catch basins and inlets on Belchertown Road (Route 9) to drain into the gravel wetland and not directly into Muddy Brook and stabilize the access road.

Photo 1-1: Standing water in grassed depression.

Photo 1-2: Belchertown Road embankment.

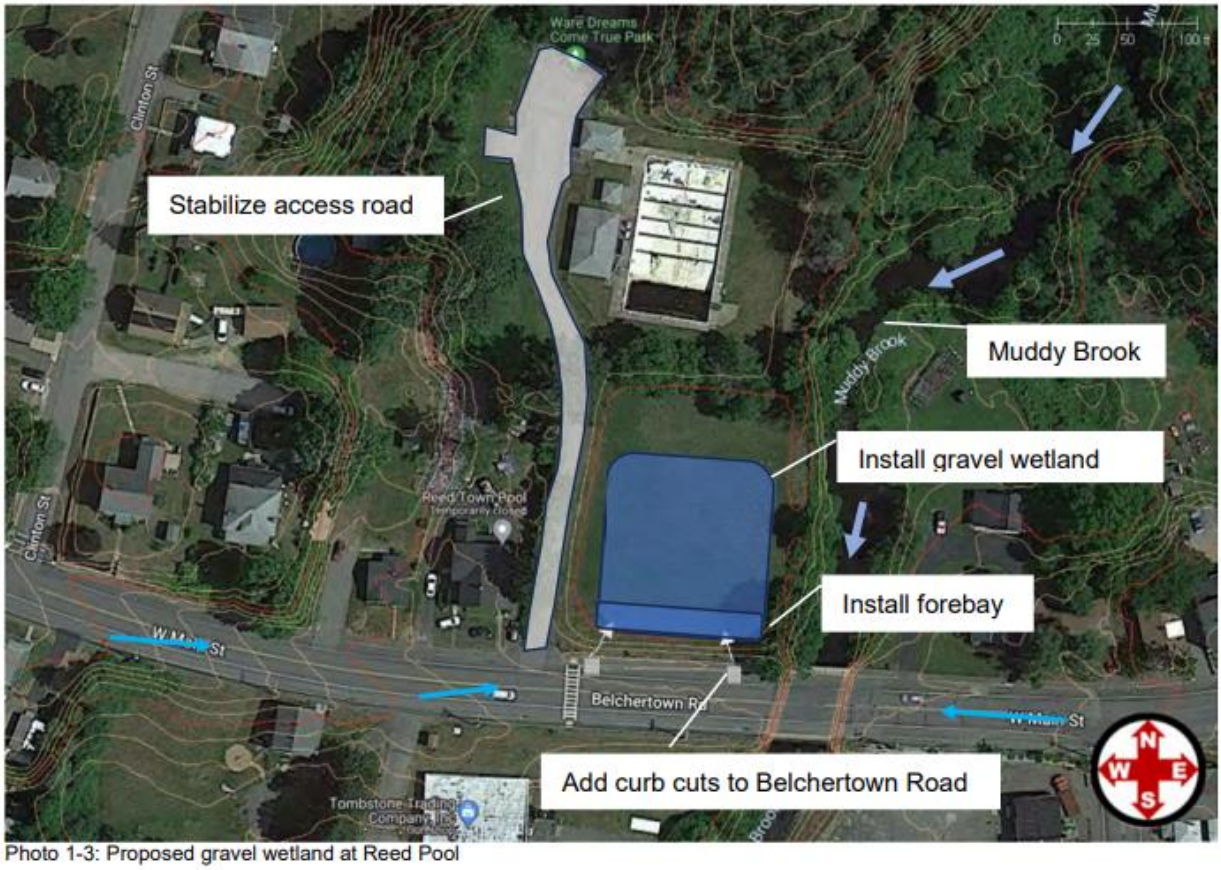


Photo 1-3: Proposed gravel wetland at Reed Pool

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Behind the playground at the Ware Dreams Come True Park there is a large grassed area that abuts Muddy Brook. The area extends over two perched High Density Polyethylene (HDPE) culverts serving as an overflow bypass for

the Brook. There are wide recreational areas adjacent to the Brook and erosion along the bank. Recommendations to incorporate nature based solutions in this area includes removing the two culverts and daylighting the stream, and implementing a no-mow areas to provide an enhanced natural buffer while still allowing access trails to the Brook for recreation (approx. 33, 000 square feet).

Photo 2-1: Open grassed field.

Photo 2-2: Grassed crossing of the two culverts.

Photo 2-3: Erosion along bank.

KUBINSKI FIELD

Kubinski Field is located close to several of the municipal water supply wells and is therefore falls under the jurisdiction of the Department of Public Works (DPW). The baseball diamond is maintained by the Parks Department. The field is used by both youth and adult baseball programs. A high priority goal identified in the 2023 OSRP is to relocate Kubinski Field parking lot from the Zone I Groundwater Protection District to Town-owned land on Pleasant Street.

An U.S. Army Corps-maintained levee separates Kubinski Field and the Ware drinking water treatment facility from Snow Pond to the northwest. The grassed area around the pump houses and Barnes Street appears to have significant animal waste, particularly from geese. Runoff from Kubinski Fields and the surrounding hills shed toward the levee and is collected by catch basins in the road and grassed areas. The catch basins discharge into Muddy Brook without treatment. Proposed improvements include installing biofiltration areas around the pump house and at the bottom of Barnes Street hill (approx. 5,000 square feet) and establishing no-mow areas in the grassed areas surrounding pump houses and the levee (approx. 30,000 square feet). The Town should also note that no woody vegetation should be allowed to establish on the levee itself.

Photo 3-1: Grassed area surrounding the pump house and levee.

Photo 3-2: Grassed area surrounding the pump house and levee.

Photo 3-3: Catch basin by the pump house.

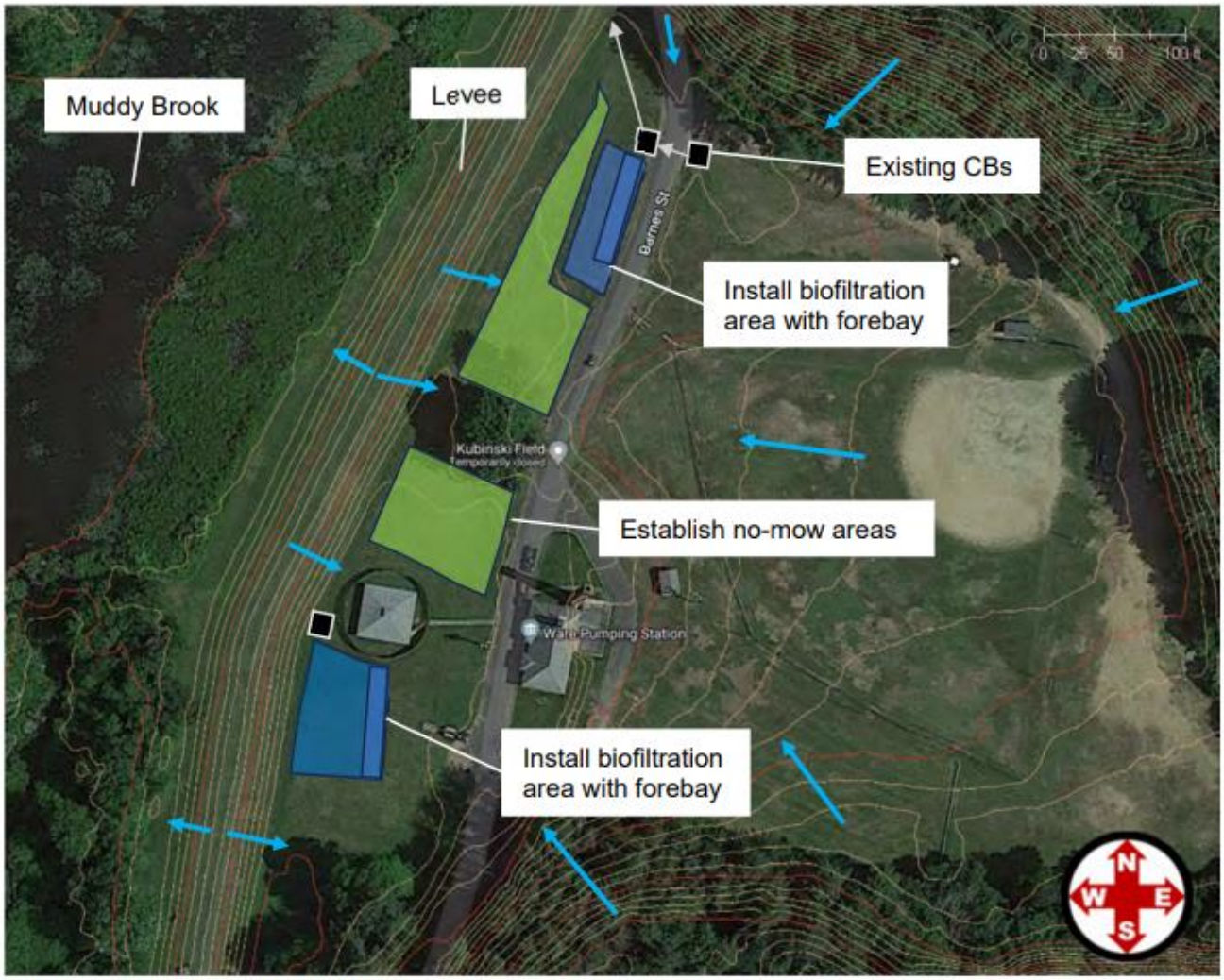


Photo 3-4: Proposed BMP at Kubinski Fields

SNOW POND DAM

Snow Pond is a 25-acre impoundment owned by the Town of Ware. Pleasant Street is bridged over Muddy Brook, just downstream of the Snow Pond Dam. There is a loose gravel pull-off for recreational access to the Snow Pond Dam on the east side of Pleasant Street. Sediment is tracking out of the pull-off area and into a catch basin located to the north. The catch basin discharges directly into Muddy Brook to the west. Runoff from the east side of Pleasant Street channelizes along the shoulder before being captured by the same catch basin. Runoff that is not captured by the catch basin flows toward the Pleasant Street crossing and sheds to Muddy Brook along the top of the wing walls. There is also evidence of some erosion along the wing wall of the culvert.

Proposed improvements include adding check dams and a sediment trap along the southern wing wall, stabilizing the existing parking pullout (approx. 1,000 square feet), enhancing the vegetative buffer along the side of the brook and seeding and grassing the top of the levee at the dam.

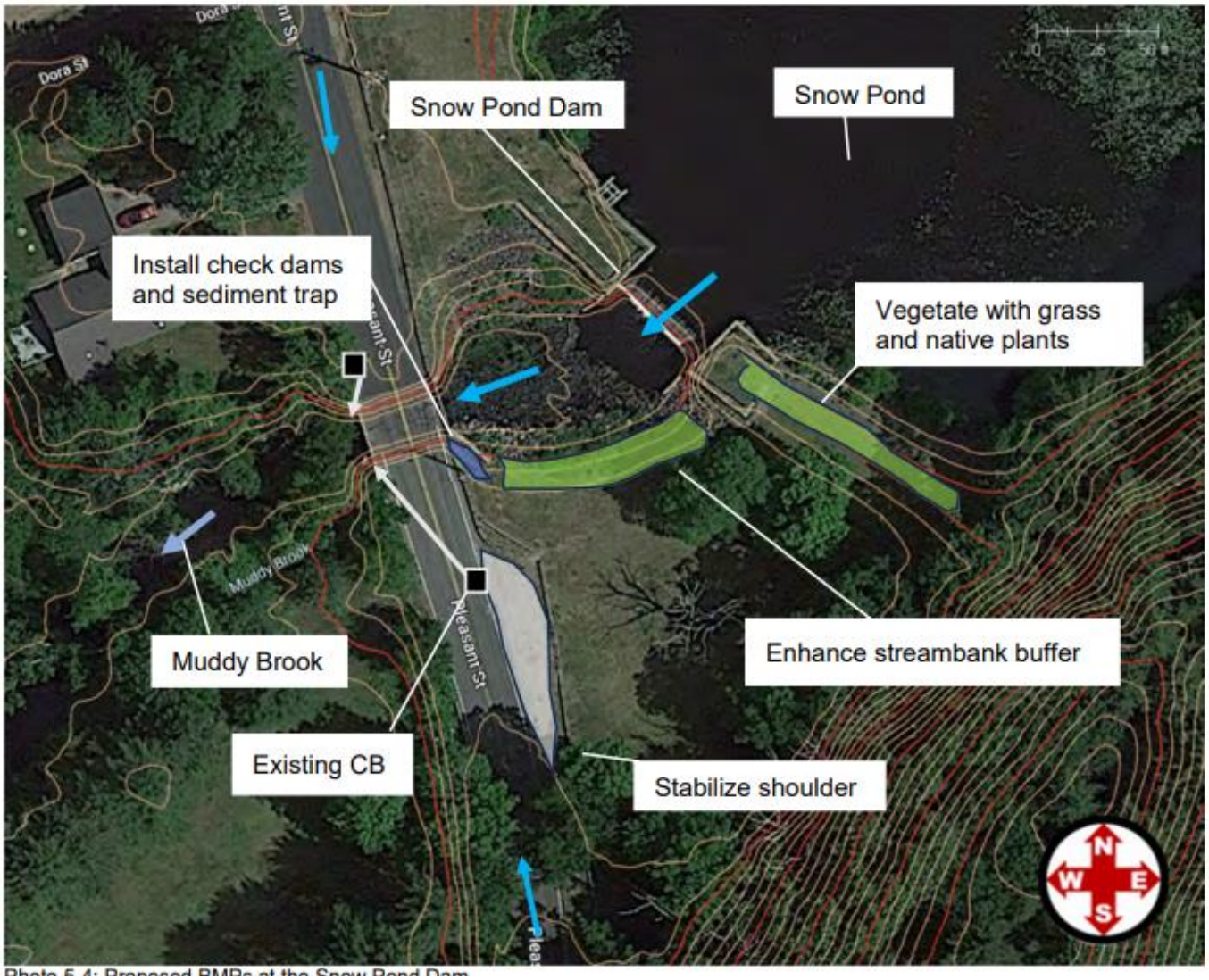


Photo 5-4: Proposed BMPs at the Snow Pond Dam

ASPEN GROVE CEMETERY

Aspen Grove Cemetery is a hilly area with paved roads providing access to many areas of the cemetery. At the entrance of the cemetery from Pleasant Street there is a triangular portion of grass that receives runoff from the surrounding hills to the north and west. It appears that a tree was previously removed from this area. Runoff currently flows over this area and washes sediment into the drainage system on Pleasant Street. Proposed improvements include installing a bioretention basin at the corner entrance to Aspen Grove Cemetery (approx. 400 square feet).

Photo 6-1: Grassed area by the entrance to Aspen Grove Cemetery.

Photo 6-2: Retaining wall along Pleasant Street at the entrance to Aspen Grove Cemetery.

Photo 6-3: Upstream contributing area to the grassed patch.

Photo 6-4: Proposed BMP at the entrance to Aspen Grove Cemetery

There is also an area used for material stockpiling within the Aspen Grove Cemetery which abuts a ditch that drains to Muddy Brook. There are multiple stockpiles in the area including gravel and other sediment. The stockpile area is at a low point within the surrounding area. Runoff from the roads and hills sheds across the stockpile area before going into the adjacent tributary. Proposed improvements include relocating stockpiled materials away from the contributory ditch, stabilizing loose sediment stockpiles and driveway (approx. 4,750 square feet), and providing an enhanced vegetated buffer in this area to discourage access to the stream and material storage (approx. 750 square feet).

Photo 7-1: Stockpile area as seen from the cemetery access road.

Photo 7-2: Entrance to gravel stockpile area.

Photo 7-3: Stockpiled material along contributing ditch.

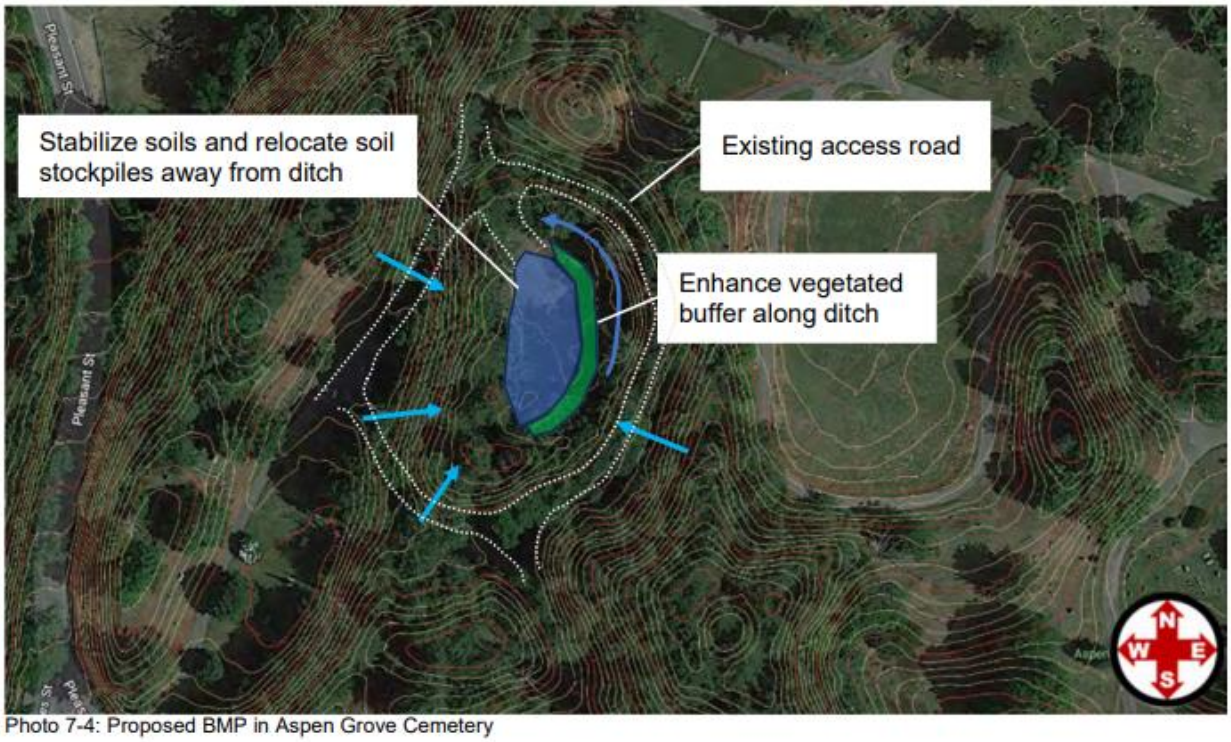


Photo 7-4: Proposed BMP in Aspen Grove Cemetery

Additionally, portions of the Aspen Grove Cemetery Road traverse the bank of Snow Pond. Runoff from the road and the surrounding hills sheds over the embankment and into Snow Pond. There are several open grassed areas along the roads that allow access to Snow Pond. There are signs of recreational access to Snow Pond with minor erosion along the bank. Proposed improvements include enhancing the buffer in the grassed areas along Snow Pond (approx. 1,250 square feet).

Photo 8-1: Grass embankment of Snow Pond next to cemetery access road.

Photo 8-2: Narrow grass embankment of Snow Pond.

Photo 8-3: Proposed BMP at Aspen Grove Cemetery along Snow Pond

OPPORTUNITIES FOR REDEVELOPMENT PROJECTS

Building resilience through development and redevelopment projects in the neighborhoods of the Muddy Brook watershed involves two interrelated strategies: minimizing impervious cover (driveways, rooftops, and parking lots) and maximizing use of green vegetated areas, particularly the use of trees. These strategies can have multiple benefits across Ware's neighborhoods with direct benefits to Muddy Brook. Most importantly, these include reducing storm flows and localized flooding, and providing cooling during hot summer days. Soils, vegetation, and particularly trees can soak up rainfall as well as lower surface and air temperatures through shading and evapotranspiration, the return of moisture to the air by plants through transpiration. Shaded surfaces can be 20 to 40 degrees cooler than non-shaded surfaces, thus providing cooling on hot summer days that also helps to reduce electricity demand for air conditioning.

What is interesting about the downtown urbanized area of Muddy Brook is there are several facilities that are considered Land Use with Higher Potential Pollutant Load (LUHPPL). A LUHPPL is an area where land use has the potential to generate highly contaminated runoff. With concentrations of pollutants exceeding those typically found in stormwater. For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If, through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by DEP to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. Ch. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00, and 314 CMR 5.00.

Land uses with higher potential loads include land uses that DEP has determined are not suitable for Zone II and Zone As areas of public water supplies, including, without limitation, the following:

- automobile junk yards;
- the removal of sand and gravel within four feet of the historical high water mark;
- the storage of hazardous materials;
- liquid petroleum, liquid propane, chemical fertilizers, pesticides, manures, septage, sludge, road-deicing materials or sanding materials;
- snow or ice that has been removed from roads and is contaminated with de-icing chemicals;
- cemeteries, mausoleums;
- bulk oil terminals; and
- commercial washing of vehicles and car washes.

In addition, land uses with higher potential pollutant loads include:

- exterior fleet storage areas;
- exterior vehicle service maintenance and cleaning areas; and

- parking lots with high-intensity-uses (1,000 vehicle trips per day or more). Shopping centers, malls, and large office parks typically have high-intensity-use parking lots.

Furthermore, Muddy Brook is a designated Cold-Water Fisheries Resource, making it also a critical area under MA DEP Stormwater Regulations. Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, considering site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to Zone I or Zone A areas are prohibited unless essential to the operation of a public water supply. This poses an interesting and unique challenge for redevelopment in the downtown area of Muddy Brook, which may require innovative approaches to stormwater standards.

OPPORTUNITIES FOR REDEVELOPMENT OF EXISTING INFRASTRUCTURE IN URBANIZED AREAS

Urban revitalization and redevelopment of existing infrastructure can advance the goals of this plan dramatically, but meeting MA DEP Stormwater Regulations will be a limiting factor especially if DEP promulgates the proposed 2024 revisions to the Wetlands Protection Act (WPA) regulation as written. This will provide an opportunity to promote and encourage off-site redevelopment in the Muddy Brook Watershed and establish a fee program where a developer could "bank" credits for Total Phosphorus (TP) at a suggested rate of $40,000/1lb of TP. If, for instance, a private developers cannot meet Total Suspended Solids (TSS) or Total Phosphorus (TP) removal requirements on site, other projects designated as high priority by the Town could be completed by utilizing off-site mitigation or a fee program.

Table 4.2: Urbanized Sites for Potential Redevelopment

Property Name	Owner/ Manager	Current Use	Address	Map/Lot	Area (Acres)
McDonalds	Mc Donalds Corporation	Restaurant	117 West Street	56-0-11	1.21
Taco Bell	Aldrich Management Corp.	Restaurant	118 West Street	56-0-93	0.44
Phillps Plaza Shopping Center - O'Reilly's Auto Parts, Curaleaf	Aldrich Management Corp.	Parking Lot, Restaurant & Recreational Marijuana	124 West Street	56-0-94	7.00
Edgar Machine	David Edgar	Auto Machine Shop	132 West Street	56-0-95	0.36
Swift River Valley Auto Wash	Nor Cor Auto wash Inc.	Car Wash	134 West Street	56-0-96	0.74
Monson Savings Bank	Monson Savings Bank	Bank	136 West Street	56-0-98	1.27

Big Y	D'Amour	Grocery Store	148 West Street	56-0-102	8.59
Rollaway Lanes Bowling Alley	Roland Josefiak	For sale	140 West Street	56-0-99	1.07
Ware Coin Laundry	Carlos Martin	Laundromat	142 West Street	56-0-100	0.39
R & K Auto Repair	Scott Pisarski	Auto Repair	118 W. Main Street	59-0-119	0.74
Kippy's Auto Repair	Philip Arello	Auto Repair	2 Vernon Street	56-0-117	1.66
Overflow Parking Lot	Philip Arello	Auto Repair/Auto Storage	Vernon Street	56-0-118	1.84
SubaGuru of MA	CKG Properties LLC	Auto Repair	105 West Street	56-0-115	0.24
Brookside Mart	Brookside Mart	Gas Station	131 West Street	56-0-109	0.45
Subway & Dunkin Donuts	Alexandria Trust, LLC	Restaurant	139 West Street	56-0-107	1.73
Moulton Insurance Agency	413RSCS2 LLC	Insurance	143 West Street	56-0-106	0.2
Country Bank	Country Bank for Savings	Bank	155 West Street	56-0-105	1.7
R & K Auto Repair	Scott Pisarski	Auto Repair	118 W. Main Street	56-0-119	0.74
Highland Village	Highland Ware Associates Limited	Housing	27 Boulder Drive	63-0-122	12.14
Hillside Village	Hillside Properties, LLC	Housing	17 Convent Street	63-0-134	6.00
Mobile Home Park	Eric Moulton	Housing	221 Upper North Street	29-0-50	10.31
Mt Carmel Cemetery	Romal Catholic Church	Burial ground	Greenwich Road	23-0-6	12.00
New St. Williams Cemetery	Romal Catholic Church	Burial ground	West Main Street	56-0-110	24.00
Old St. Williams Cemetery	Romal Catholic Church	Burial ground	West Street	56-0-26	5.49
TOTAL ACREAGE				**100.31**	

ADDITIONAL OPPORTUNITIES FOR REDEVELOPMENT OF RURAL DISTURBED LANDS

The rural areas of northern Ware have strong assets to leverage and advantages that can be built on to enhance economic vitality. First, the natural beauty and physical landscapes of rural areas are conducive for outdoor recreation and tourism. Mountains and forests allow for walking, hiking and world-class mountain biking facilities; and rivers, lakes and ponds for swimming, kayaking, fishing and other water sports. Second, rural areas represent the agricultural history of Massachusetts and encourage the movement toward small-scale farming. Locally made food and beverage products can be an innovative way to strengthen Ware's economic base and increase tourism as well.

Table 4.3: Rural Sites for Potential Redevelopment			
Current Use	**Location**	**Map/Lot**	**Area (Acres)**
Exposed open gravel pit	25 Hardwick Pond Road	40-0-38	38.8
Earth Removal Operation	1555 Greenwich Road	40-0-79	37.9
Earth Removal Operation	Greenwich Road	35-12-1	36.2
Trucking company	203 Osborne Road	39-0-21	44.53
Unpermitted Junkyard/Transfer Station	81 Greenwich Road	29-30-1; 29-30-2	5.03
Cow farm	8 Hardwick Pond Rd	40-0-23	7.86
Five Star Ranch -Alpacas	124 Old Gilbertville Road	36-0-1	28.44
Highland Woodlot	0 North Street	63-130-1	3.04
Possible Landscaping Company	Sorel Road	35-2-3	14.99
TOTAL ACREAGE			**216.79**

OPPORTUNITIES FOR LAND ACQUISITION

Protecting open space is important to ensure that future generations have land available for farming, timber production, and recreation. Open space also protects water supplies from degradation associated with increased development. Protecting open space is critical to preserving habitats and habitat corridors for wildlife, from insects to moose and bears. Open space helps maintain clean air which all life depends on, whether plant or animal. Protecting land for recreational purposes, both active and passive, is important to ensure that future generations have places to play sports or simply walk among fields or trees, observing the natural world. Such activities are important for human health, helping with issues such as weight control, cardiovascular health, and stress reduction among many other benefits.

OPEN SPACE AND RECREATION WITHIN THE MUDDY BROOK WATERSHED (MAP 11)

The Town of Ware owns 529.2 acres of land for conservation and recreation purposes with the Muddy Brook Watershed. This includes several large tracts of protected land, including land conserved by the East Quabbin Land Trust (EQLT), the Town Forest, and areas around Snow Pond and the Town drinking water wells. This section will identify existing protected open space and identify strategic parcels for potential acquisition that connect existing conservation properties, and identify parcels located within the Zone II Groundwater Protection District.

The Town Forest is comprised of three different non-contiguous parcels. The “Muddy Brook” lot is approximately 66 acres and is surrounded by forest and agricultural properties, some in Chapter 61 or 61A, and the land to the north is permanently protected by the EQLT through a conservation restriction. The Muddy Brook Town Forest lot has two access roads that are maintained by hikers and recreational ATV users. There are several smaller trails that connect the roads. This parcel provides important habitat for many species and the corridor along the Brook has been identified as a priority habitat by the Natural Heritage and Endangered Species Program (NHESP). The

Town Forest is managed under a Forest Management Plan developed with assistance from PVPC, with the goal of developing adequate trails while maintaining the forest's natural resources.

Hyde Woodland Preserve is a 100-acre parcel owned by the East Quabbin Land Trust and is located along the southern flank of the Dougal Range. The property is entirely forested and is dominated by white pine and a mixture of hardwoods. The property is divided by the heavily eroded and abandoned Old Stagecoach Road, a public way, which is currently overtaken by a host of invasive plants. This old town road once connected Old Gilbertville Road to Hardwick Pond Road. Interesting stone walls, cellar holes, and unique landscape features such as steep talus slopes are found throughout the property. The property is currently open for hunting, fishing, and passive recreation. Access to the property from existing trails along the Dougal Range, through the adjacent Ware Town Forest parcel, or from Hardwick Pond Road via the abandoned section of Old Stagecoach Road. In 2016, EQLT and the Town worked to establish a small trailhead parking area on Old Gilbertville Road with a trail leading to the Hyde Woodland Preserve via Old Stagecoach Road. Hyde Woodland preserve directly borders Muddy Brook and is adjacent to the Muddy Brook Town Forest lot. The Town oversees a conservation restriction on the parcel.

Table 4.4: Existing Protected Open Space Land – Including Agricultural Preservation Restrictions (APR) & Conservation Restrictions (CR)

Property Name	Owner/ Manager	Location	Map/Lot	Area (Acres)
Ware Town Forest	Town of Ware	Greenwich Road	29-0-72	13.50
Ware Town Forest	Town of Ware	Greenwich Road	35-15-1	66.38
Ware Town Forest	Town of Ware	Upper North Street	29-0-46	6.31
Klassanos CR	Brian & Martha Klassanos & EQLT	25 Hardwick Pond Road	40-0-38	38.80
Klassanos CR	Brian & Martha Klassanos & EQLT	Old Stagecoach Road	40-0-37	4.82
Klassanos CR	Brian & Martha Klassanos & EQLT	Old Stagecoach Road	40-0-35	6.95
Finn Woodland	EQLT & Ware Conservation Commission	Old Stagecoach Road	40-36-1	37.82
Open Space	Town of Ware	Old Gilbertville Road	40-0-36	25.11
Storrs Conservation Land	Town of Ware	Pleasant Street	60-232-1	1.3
Snow's Pond	Town of Ware	Greenwich Road	23-0-8	11.40
Hyde Conservation Area	EQLT & Ware Conservation Commission	Old Stagecoach Road	40-0-80	61.78
Strawberry Fields CR	Penny Lane Development, LLC	Off Greenwich Road	40-0-52	8.56
Turkey Street Preserve	EQLT & Hardwick Conservation Commission	Hardwick Pond Road	44-0-4	1.62
TOTAL ACREAGE			**284.35**	

LANDSCAPE CSONNECTIVITY

The goal of this section is to identify a network of resilient sites and linkages, that if adequately managed or conserved, would sustain the diversity of the Muddy Brook Watershed under a dynamically changing climate. Preserving or creating landscape connectivity has become increasingly recognized as a key strategy to protect biodiversity, maintain viable ecosystems and wildlife populations, and facilitate the movement and adaptation of wildlife populations in the face of climate change. The degree to which landscapes are connected determines the overall amount of movement taking place within and between local populations. This connectivity has influences on gene flow, local adaptation, extinction risk, colonization probability, and the potential for organisms to move and adapt to climate change. With habitat loss and fragmentation increasingly deteriorating natural habitats, the sizes and isolation of the remaining habitat fragments are particularly critical to the long-term conservation of biodiversity. Thus, protecting large landscapes and connecting them can prevent common species from becoming uncommon or even endangered. Connectivity is key to supporting species diversity. The following tools were used to identify parcels for potential acquisition to increase landscape connectivity

MASS MAPPING & PRIORITIZING PARCELS FOR RESILIENCE (MAPPR)

The Mass Mapping & Prioritizing Parcels for Resilience (MAPPR) allows land conservationists to identify the parcels within an area of interest that are the highest priorities for protection based on habitat quality, climate change resilience, water resource protection, parcel size and adjacency to existing protected parcels. MAPPR uses a variety of data sources to help prioritize parcels for conservation, including BioMap2, a precursor to Resilient & Connected Landscapes, and Critical Linkages Priorities (DSL-Conductance). There are four pre-calculated models, or a user can create a customized prioritization by selecting individual factors of importance.

Website: Mapping and Prioritizing Parcels for Resilience Project (massaudubon.org)

THE ADAPTATION WORKBOOK

The Adaptation Workbook is a structured process to consider the potential effects of climate change, and to design land management and conservation actions that can help prepare for changing conditions. The process is completely flexible to accommodate a wide variety of geographic locations, ownership types, ecosystems, land uses, management goals, and project sizes. The Adaptation Workbook walks users through a process for considering climate change impacts and identifying management actions that could be taken to directly adapt to climate change. This resource incorporates rigorous science, with information and “menus” of actions for forests (including urban forests) and agricultural lands. The output of the process is a comprehensive climate adaptation plan. This application is most useful for users with clear management goals and knowledge about their property or ecosystem of interest. This tool includes a large number of case studies that show how Adaptation Workbook has been used by forest conservation practitioners.

Website: Home | Adaptation Workbook

MASSACHUSETTS CONSERVATION ASSESSMENT & PRIORITIZATION SYSTEM (MASSCAPS)

Massachusetts Conservation Assessment & Prioritization System (MassCAPS) is an approach to prioritizing land for conservation based on the assessment of the ecological integrity for various natural communities (e.g. forests, headwater streams). Several metrics are applied to the landscape and then integrated in weighted linear

combinations to create models for predicting ecological integrity. This process results in an Index of Ecological Integrity (IEI) for each point in the landscape based on models constructed separately for each ecological community based on human impacts and landscape characteristics, to highlight examples of ecosystems that are likely to maintain their natural composition, structure and function over time, in Massachusetts. It is most suitable for landscape-scale conservation and climate adaptation. While MassCAPS does not explicitly focus on climate adaptation, areas with high IEI scores tend to be large, well-connected areas buffered from human activities, where natural processes are likely to remain intact over time. Within intact areas, natural systems are more likely to be resistant and resilient to impacts - from both humans and climate change. Areas of high IEI are likely to provide a diversity of niches and migration pathways important for maintaining biodiversity as climate change shifts species distributions over time.

Website: Conservation Assessment and Prioritization System (umasscaps.org)

MASSACHUSETTS CLIMATE ACTION TOOL (CAT)

The Massachusetts Climate Action Tool (CAT) provides access to information on climate change impacts and vulnerability of species and habitats, as well as adaptation strategies and actions to help maintain healthy, resilient natural communities, with a focus on Massachusetts. The purpose of the CAT is to present research-based information about climate change impacts and the vulnerabilities of various fish, wildlife and habitat, and promote adaptation actions that can be taken at a local level. This information is paired with a map viewer to access online GIS data that was selected or synthesized to understand and respond to conservation challenges posed by climate change. The tool contains approximately 200 GIS layers as well as a wealth of information on climate-related stressors affecting Massachusetts, vulnerability assessments for over 60 species or groups of species, and a substantial list of adaptation actions ranging from forest management and land preservation to culvert replacement and dam removal. The CAT was designed for users with limited mapping capacity, and features maps that incorporate BioMap3 and the CAPS (Conservation Assessment & Prioritization System), Index of Ecological Integrity (IEI), DSL (Designing Sustainable Landscapes) conductance, as well as other spatial data. Species profiles include spatial data showing the current geographic distribution or habitat suitability for the species and, in many cases, projections for the future habitat suitability accounting for climate change.

Website: Resources: Massachusetts Climate Action Tool | Center for Agriculture, Food, and the Environment at UMass Amherst

NEW ENGLAND LANDSCAPE FUTURES (NELF) EXPLORER

New England Landscape Futures (NELF) Explorer is unique in incorporating social, economic and environmental perspectives on potential future land use patterns, and it is the best tool for practitioners interested in exploring these broader and more comprehensive considerations. NELF Explorer is a scenarios-based interactive land-use mapping tool that allows users to visualize alternative future land uses over time and multiple spatial scales including all New England, states, watersheds, and municipalities. Users can also gain an understanding of how the different land-use scenarios, including a business-as-usual scenario called Recent Trends, would affect high priority land for conservation such as wetlands, rare species habitat, and areas of high ecological integrity. The Recent Trends scenario continues rates and patterns of land-use change that occurred between 1990 and 2010

through to the year 2060. The four other NELF scenarios were created with New Englanders from all six states concerned about the future of the land and are conceptually based on the factors driving changes to the land that stakeholders perceived to be the most impactful and the most uncertain.

Website: NELF Explorer (newenglandlandscapes.org)

NATURE'S NETWORK

Nature's Network is a collaborative effort led by the U.S. Fish & Wildlife Service and representatives from all 13 Northeast states, using innovative modeling approaches developed by UMass Amherst and other science partners, to identify the best opportunities for conserving and connecting intact habitats and ecosystems and supporting imperiled species, to help ensure the future of fish and wildlife across the Northeast region. Nature's Network offers a regional landscape conservation design and a suite of decision-support tools that makes available much of the state-of-the-art modeling done by the Designing Sustainable Landscapes (DSL) project at UMass Amherst. The web mapper interface presents a huge variety of customizing options, that frequent users will familiarize themselves with and use. Nature's Network incorporates DSL Ecological Integrity Metrics, DSL-Conductance, and Resilient & Connected Landscapes. Elements of Nature's Network include Terrestrial and Wetland Core Network, Habitats for Imperiled Species, Aquatic Core Networks, Marsh Migration Zones and Regional Flow. Some elements of Nature's Network, such as the Terrestrial and Wetland Core Network, represent a regional plan for conserving wetland and terrestrial biodiversity. Other components, such as Habitats for Imperiled Species and Marsh Migration Zones, can be used as inputs for creating conservation plans at the local, state or regional scales.

Website: NaNet homepage | Northeast Conservation Planning Atlas (arcgis.com)

Table 4.5: Potential Acquisition for Landscape Connectivity

Location	Map/Lot	Area (Acres)	Current Use
19 Sheehy Road	29-53-1	32.85	largely undeveloped but with fields
28 Sheehy Road	29-0-48	161.88	largely undeveloped but with a field and some exposed soils with trucks
Off Greenwich Road	35-0-15	50.5	Vacant Land connecting town land to EQLT land
238 Upper North Street	29-0-68	7.79	Contains Knights Pond that feeds into Snow Pond
Clinton Street	62-90-1	12.48	Single family house with tributary through lawn
Hardwick Pond Road	43-0-12	39	Woods & wetlands
Hardwick Pond Road	40-0-25; 40-0-26; 40-0-27; 40-0-41; 40-1-41	51.5	Open fields
124 Old Gilbertville Road	36-0-1	28.44	Five Star Ranch; alpacas; tributary starts on farm

Campbell Road	43-0-2; 43-1-1; 43-1-2; 43-3-2; 40-14-1	33.7	Open Fields
Greenwich Road	40-0-70	37.9	Forest
Greenwich Road	40-0-3	6.3	Forest
73 Hardwick Pond Road	43-0-14	30.67	Forest
Hardwick Pond Road	43-0-15	35.02	Forest
Hardwick Pond Road	43-16-1	64.3	Forest
57 Hardwick Pond Road	43-0-17	32.5	Forest
Old Stagecoach Road	40-36-2	86	Forest
Hardwick Road	40-0-27	22.32	Open Fields
Osborne Road	40-0-8	57.63	Forest
Osborne Road	39-0-21	44.53	Forest
Osborne Road	39-0-9	26.5	Forest
Walker Road	28-42-1	90.71	Extensive wetland complex with several tributaries
Greenwich Road	29-10-7	12	Forest
Greenwich Road	29-0-10	11.2	Forested Wetlands
Greenwich Road	23-0-7	11.62	Open Land
Walker Road	28-0-6	24.46	Forested Wetlands
Walker Road	28-0-51	11.52	Forested Wetlands
Walker Road	28-0-50	10.48	Forested Wetlands
TOTAL ACREAGE		**1,033.8**	

SNOW POND RESTORATION OPTIONS

IN-LAKE RESTORATION OF SNOW POND (MAP 12)

Snow Pond is an approximately 25 surface acre waterbody in Ware. Snow Pond was once a favorite destination for fishing, walking, and picnicking. The survey documented extensive invasive weed growth, which has increased eutrophication of the pond. The dense plant growth has decreased fish and wildlife habitat and recreational value. The pond is owned by the Town and is located within Zone II of the Town's public water supply and feeds the aquifers that recharge the Town's well fields. These factors are a major limiting factor when developing management strategies.

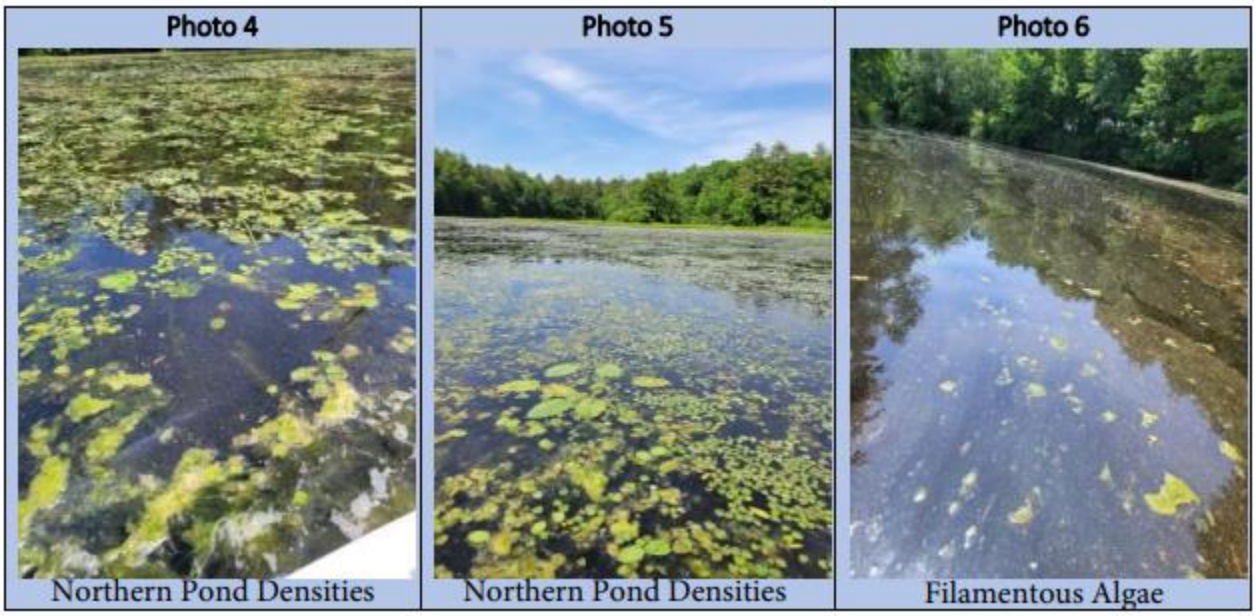
On June 4, 2024, Aquatic Biologist, Grace Adams, and Aquatic Field Assistant, Harley Westgate, of Water & Wetlands, performed a site visit to Snow Pond to conduct a survey. Visual observation and a standard throw-rake and handheld GPS/ArcGIS Field Maps were utilized. Plants documented during the survey are documented in the table below. An "*" denotes an invasive species. Invasive species are non-native to the ecosystem and are likely to cause economic harm, environmental harm, or harm to human health.

Table 5.6: Species Identified	
Common Name	**Latin Name**
Variable Milfoil*	*Myriophyllum heterophyllum*
Fanwort*	*Cabomba caroliniana*
Watershield	*Brasenia schreberi*
Yellow Water Lilly	*Nuphar variegate*
Filamentous Algae	
Ribbon Leaf Pondweed	*Potamogeton epihydrus*
Arrowhead	*Sagittaria latifolia*
Ribbon Leaf Pondweed	*Potamogeton natans*
Burreed	*Sparganium*

While onsite, dissolved oxygen (DO) and temperature readings were collected using a calibrated YSI meter with optical sensor. Dissolved oxygen is the amount of oxygen in water that is available to aquatic organisms. DO is necessary to support fish spawning, growth, and activity. Dissolved oxygen can be affected by many outside factors, including temperature, time of day, and pollution. Dissolved oxygen levels are typically lowest early in the morning. Healthy water should generally have concentrations of about 6.5-8+ mg/L. A Secchi disk is a disk with alternating black and white quadrants. It is lowered into the water of a lake until it can no longer be seen by the observer. This depth of disappearance, called the Secchi depth, is a measure of the transparency of the water. The surface temperature was 81 degrees F, the DO level was 11.86 mg/liter and the Secchi disk measured clarity 4'1" -to the bottom.

Conditions during the survey were sunny and calm. Water clarity during the survey was excellent, resulting in high visibility throughout the water column high. In addition to visual observation, the survey utilized a throw-rake to identify species and densities. Two invasive species were found during the survey: fanwort and variable watermilfoil. These species have a universally dense composition across the entire pond. The central channel was the most navigable portion of the pond as it was predominantly populated by burreed. Water lilies and Watershield were interspersed throughout the pond's surface mixed with moderate densities of filamentous

algae. Native ribbon leaf pondweed was also present within the pond. When found, it was covered in epiphytic algae indicating the plants are not healthy and/or dying and decaying. It appears the invasive species have outcompeted the beneficial pondweeds thus decreasing biodiversity among submerged aquatic plant species.



Based on the survey data collected, management of Snow Pond is called for. Invasive species have largely taken over the pond, disrupting recreational uses but more importantly having negative impacts on the ecosystem. Fanwort and variable milfoil have negative impacts largely due to their dense foliage. The excessive plant cover

can reduce fish density. Competitive, vegetative growth also reduces light for benthic organisms and native plants. As a result, dense monocultures have formed and species richness within the pond is greatly reduced.

Varying management options were considered. Several small-scale strategies were considered such as Diver Assisted Suction Harvesting (DASH). Diver Assisted Suction Harvesting is the process of lake weed removal in which a diver visually identifies the plant being targeted, removes it by the root system, and deposits it into a containment bag at the surface via a suction hose, allowing for bulk removal. By removing the invasive or nuisance species that is causing the problem, the capability of native plants to repopulate the areas that they have been pushed out of increases, giving the system a chance to return to a natural balance. The extraction of each plant by its root system is important as it provides carryover control into later years. This approach will provide some control of the target species within Snow Pond and is a common management technique used within restricted sites (water supply, etc.).

In lieu of DASH, hand-pulling may Bagged invasive plants removed through hand-pulling be used due to depth and lack of access for DASH equipment. This approach typically deploys a crew of four hand-pullers to selectively hand-pull the target species and place the removed material into bags to then be removed from the regulated area. Unfortunately, both processes become extremely difficult and expensive when faced with the densities and cover of invasive plants found at Snow Pond. These strategies are likely best suited to manage regrowth following an initial restoration.

Several other strategies were considered and quickly ruled out. Benthic mats are mats placed in small areas to shade sunlight, thus limiting all plant growth in a target area. This approach can be beneficial in beach or swimming areas but is neither practical nor cost effective pond-wide. Additionally, this approach is non-selective. In many states, stocking of triploid grass carp is used for pond-wide vegetation control. This species of fish eats vegetation thus potentially providing control and reduction in overall vegetation biovolume. The challenge with grass carp is that they are non-selective and often choose to eat beneficial native vegetation prior to turning to target species. Ultimately this option was quickly ruled out as it is prohibited altogether in Massachusetts.

Mechanical plant control can be extremely effective at controlling certain invasive species, such as water chestnut, which was luckily not found within Snow Pond. This includes both mechanical harvesting and hydro-raking. Mechanical harvesting cuts and collects plants. Harvesting is costly and at best would only provide temporary relief from the vegetation growth with no chance of long-term success. The disruption and non-target impacts would be more significant than using other management methods thus ruling out this potential option. Mechanical hydro-raking, which is a barge powered by paddle wheels equipped with a York rake attachment was also ruled out for similar reasons. This method does remove roots, as well as organic material; but it is non-selective, disruptive, costly, and disturbs the bottom sediments which leads to added permitting restraints. Most importantly, both fanwort and variable milfoil spread through fragmentation. These mechanical strategies ultimately chop up/cut plant material leading to fragments escaping and further exacerbating the problem species. Finally, access for equipment is extremely limited at Snow Pond.

Based on the above alternatives analysis, use of EPA/MA approved aquatic herbicides is the most appropriate strategy for management of the target species in Snow Pond. Herbicides are used throughout Massachusetts and are safe for both fish and wildlife. Contact herbicides such as diquat (Reward, Tribune, Mechanical harvester

cutting vegetation etc.) and flumioxazin (Clipper, Schooner, etc.) are effective at controlling the target species in Snow Pond. These herbicides are fast-acting with a short half-life, which makes them great tools for spot-treatment. Like all contact herbicides, diquat and flumioxazin only provide seasonal control, so treatment would likely be necessary on an annual basis. Costs for these herbicides typically fall in the range of $250-$500 per surface acre treated, plus the cost of permitting. Challenges may be faced with using these products within the water supply watershed, leaving better herbicide options described below.

The preferred herbicide option for Snow Pond is Sonar (fluridone). Sonar is an aquatic herbicide that was initially registered with the Environmental Protection Agency (EPA) in 1986 and has been used throughout the United States and Massachusetts for decades. The herbicide inhibits the photosynthesis process by stopping plants from making a protective pigment that keeps chlorophyll from breaking down in the sunlight. Fluridone moves quickly throughout a waterbody and is therefore usually applied as a whole pond/basin treatment, as is the recommendation for Snow Pond. This herbicide is the preferred option as it works much more slowly than contact herbicides, thus lessening the chances of a drop in dissolved oxygen. Additionally, Sonar provides rate selectivity as some plants including fanwort are susceptible to extremely low concentrations of fluridone, while other beneficial pondweeds, including ribbon-leaf pondweed (found during the 2024 survey of Snow Pond) would require maintenance of higher fluridone concentrations to be susceptible to a "full kill." Sonar is a systemic herbicide and thus may provide some carryover control of the target species. Typically, treatment with Sonar is approximately $750-$1,200 per surface acre treated. The reason for the large variation in cost is due to the sheer cost of the herbicide itself. It is dosed as a volumetric calculation so deeper waterbodies require more product. Additionally, the target concentration of fluridone must be maintained for a period of 45-60+ days, so other calculations including turnover, ability to stop/slow flow and others. are also factored when dosing. The Sonar (fluridone) product label contains language specific to potable water intakes. It reads "in lakes and reservoirs or other sources of potable water, do not apply this product at application rates greater than 20 ppb within one-fourth mile (1,320 feet) or any functioning potable water intake. At application rates of 4 to 20 ppb, this product may be applied where functioning potable water intakes are present. (Note: Existing potable water intakes which are no longer in use, such as those replaced by potable water wells or connections to a municipal water system, are not considered to be functioning potable water intakes.")

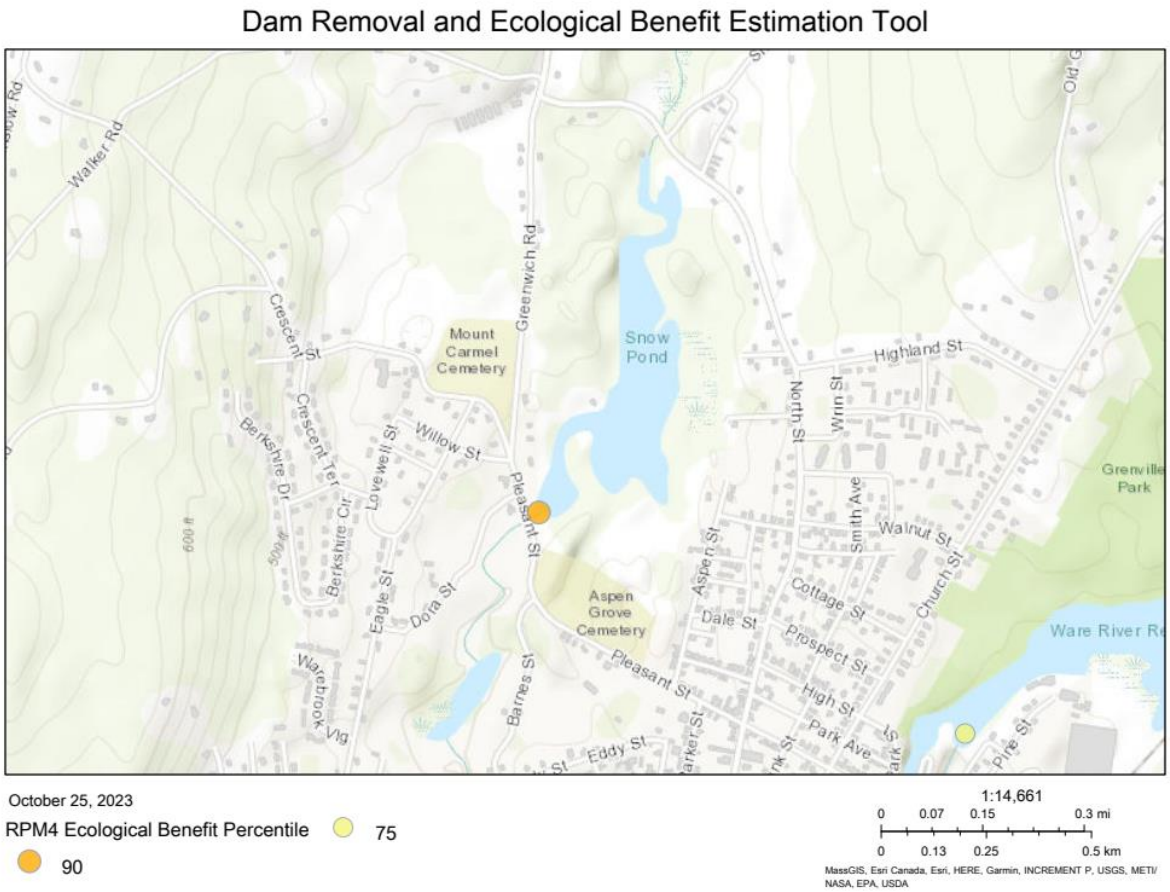
Based on this language, Sonar is the most likely solution to treatment within this sensitive area. We recommend working with the water department, MA-DCR, and SePro (manufacturer of Sonar) to develop a specific plan for treatment of Snow Pond. All management should be guided by survey data. Water quality data collection is recommended to further assess the pond's condition. In Massachusetts, ponds and lakes are heavily regulated and a Notice of Intent (NOI) must be filed with Massachusetts Department of Environmental Protection (DEP) as well as Ware Conservation Commission prior to any management. The permitting process involves preparation of the Notice of Intent, request for certified abutters list, Environmental Monitor notification, filing with DEP and Ware Conservation Commission, abutter notifications and attendance at public hearings. Typically, a three-to-five-year Order of Conditions (OOC) is issued. The OOC can also be extended for additional terms at little to no cost, at the discretion of the Conservation Commission. Following issuance, the OOC will be recorded with the registry of deeds. Snow Pond may also require consulting with additional agencies specific to rare species upstream and downstream as well as DCR & DFG. The project may require a variance to be issued by DCR. Once a valid OOC is in-hand, consultants will be able to confirm the approach and costs. The rationale for this is that the

scope of work is likely to be altered and further defined during the planning and permitting process based on what will be allowable and what special conditions are issued.

DAM REMOVAL & RIVER RESTORATION

Dams create artificial habitat by impounding water and altering river function. Impoundments trap sediment and create stagnant conditions with warmer water and lower dissolved oxygen than the rest of the river system. Dams also block the movement of fish that need to access different areas of the watershed and different habitats during their life cycle. Dam removals improve water quality, restore natural river flows, and reconnect river habitats that benefit fish and wildlife. Dam removals can also reduce threats to public safety and prevent flood damage to roads, bridges, and other downstream infrastructure. Some aging dams may be at risk of failing during large storms when powerful flood waters can cause a dam to breach. Dam removal proactively eliminates these risks. Removal of a dam is often less expensive than dam repair and avoids long-term maintenance costs. Small dams fragment the landscape and alter stream ecosystems. Dam removal is increasingly used as a strategy to remove obsolete structures and to mitigate negative impacts to humans and ecosystems. The two (2) small dams that impound Snow Pond are amplifying climate impacts by increasing stream warming, reducing access and availability of cold-water refugia, and increasing the risk of catastrophic flooding due to dam failure. Dam removal may increase the ecological resilience of the Muddy Brook ecosystems by facilitating faster recovery of biota from climate-induced disturbances. Additionally, reducing public safety risks to local communities and increasing economic benefits through dam removal projects may increase community resilience to climate change.

Dam Removal and River Restoration are jointly defined by the MA Department of Ecological Restoration (DER) as an action that removes a human-made barrier(s) from a river or stream. A dam proposed for removal may or may not be under the jurisdiction of the Massachusetts Office of Dam Safety. DER has developed a program for



proponents of dam removal, to have their project given priority project status. Projects that include multiple, hydrologically connected stream barrier removals (i.e., a dam removal in conjunction with replacement of an undersized road-stream crossing(s) or channel daylighting; multiple dam removals in a river system) are allowed and encouraged. Projects must result in habitat and ecosystem improvement in areas such as water quality, floodplain connectivity, aquatic connectivity, natural flow regime, and ecological services. Projects may include ancillary bank and channel stabilization to protect infrastructure or mitigate other secondary project impacts, so long as they do not significantly impair or impede ecological processes that would otherwise be restored by removing the dam.

BARRENS RESTORATION & PATRILL HOLLOW DAM REMOVAL – HARDWICK, MA

The greater Muddy Brook Valley represents one of the most important opportunities in Massachusetts to restore and maintain a significant collection of fire-influenced natural communities, often collectively referred to as Barrens. Barrens communities support approximately 75 species on the Massachusetts Endangered Species List, including a long list of vulnerable species identified in the MA Strategic Wildlife Action Plan. Barrens are disturbance-dependent communities. They require periodic disturbance events, in most cases fire, to keep them functioning at a high level. The Muddy Brook Valley retains a clear legacy of barrens communities which have been degraded by 75 years of fire exclusion. The Division of Fisheries and Wildlife (MassWildlife) is currently restoring the Barrens at this site. A one-time timber harvest was conducted to remove generalist species and to restore the open structure of functioning barrens communities. Long-term maintenance of these communities will involve periodic prescribed fire events. Barrens communities are incredibly resilient and highly restorable; their associated species will recolonize a recently disturbed community quickly either through the seedbank, through previously dormant rootstock, or by animals that immigrate from other similar areas.

A few growing seasons have passed since the bulk of phase I restoration was completed at Muddy Brook and there has already been an impressive ecological response, including:

- The emergence of 23 fire-influenced plants not observed prior to the restoration event, including two Endangered, two Threatened, and three Watchlist species;
- The return of the eastern whip-poor-will bird to the site following a documented 30-year absence;
- A significant increase in early successional breeding birds, including the American woodcock, prairie warbler, field sparrow, and eastern towhee;
- An increase in bee species from 36 to 103 species; and
- A growing list of specialized moths and butterflies that includes several sate-listed species.

The positive conservation results at Muddy Brook are being amplified across the region as other agencies, non-profit organizations, and institutions are learning from MassWildlife's approach to inland barrens restoration and utilizing these methods in their own habitat management efforts. Muddy Brook is now used regularly as a living laboratory to teach college students, land managers, and the public about restoration and conservation.

MassWildlife is also planning to remove the Patrill Hollow Dam. Removing the aging infrastructure will reduce safety risks for users of the Muddy Brook Wildlife Management Area. It will also reduce the potential for flooding, improve water quality, restore the natural river flow, improve aquatic habitats for fish and other aquatic life and improve outdoor recreation opportunities within the surrounding Muddy Brook Wildlife Management Area. Patrill

Hollow Dam in Hardwick, MA is a 13-foot high, 190-foot-long earthen embankment structure that impounds Muddy Brook and has a primary and an auxiliary concrete spillway. The dam is situated within the 1,937-acre Muddy Brook Wildlife Management Area (WMA). The dam's impoundment volume is approximately 50 acre-feet of water. The dam is not large and does not pose significant risk to downstream areas; however, its poor condition must be addressed. The proposed project will remove the full vertical extent of the dam and will restore the area to resemble conditions prior to the dam being built. New river and wetlands habitat will be created, and Muddy Brook will once again flow without obstruction. Construction will be conducted to avoid adverse impacts to the high-quality wildlife habitat in the Muddy Brook WMA.

Patrill Hollow Pond Dam holds back water in Muddy Brook, which is a tributary to the Ware River. The dam removal is expected to decrease stream temperature and restore natural stream flow and habitat. Many types of fish will benefit from the removal project. Muddy Brook is a Coldwater Fishery Resource (CFR) and contains a reproducing population of eastern brook trout. Common shiner, tessellated darter, blacknose dace, and creek chubsucker rely on flowing water and will likely benefit from the dam removal. These species have been prioritized as Species of Greatest Conservation Need in the Massachusetts Wildlife Action Plan.

CHAPTER 5: ADDITIONAL RECOMMENDATIONS & POTENTIAL FUNDING SOURCES

INTRODUCTION

There are several ways to advance and promote Low Impact Development (LID) and green infrastructure (GI) while minimizing impervious cover and clustering development. By ensuring there is a meaningful exploration of options to reduce impervious cover and increase tree canopy and other vegetated areas during the early design phase of publicly funded projects. This includes the Town's Capital Improvement Plan projects and Community Development Block Grant funded projects. To fully understand costs, it is important to think about the long-term ongoing public cost of allowing for substandard design, especially when it comes to impervious cover and the amount of storm runoff. There is one recent project in Ware, and several examples in other locations, where projects reportedly have increased localized flooding issues. With more attention to limiting impervious cover and improving management of storm flows, these issues could have been better addressed. Instead, it is likely that future public monies will now need to be spent to resolve these issues.

RECOMMENDATIONS

STORMWATER BYLAW (SEE APPENDIX B)

By developing and adopting stringent stormwater control standards for upland areas akin to those adopted by communities regulated under the EPA-MassDEP MS4 permit, the Town can integrate considerations of current and future storm flows, as well as advance best practices to ensure proper construction and long-term maintenance of stormwater control facilities. Such standards should be consistent across municipal code, including subdivision regulations, zoning bylaw, and general bylaws. This too can help avoid future public costs to address localized flooding caused by private development and redevelopment projects.

In addition to developing stormwater standards, it is recommended to adopt a green infrastructure policy to advance best practice in all publicly funded projects whenever possible. This policy can build intention across Town departments toward better stormwater control and resilience. It can also help publicly demonstrate the Town's commitment to improving neighborhoods using GI for better stormwater management. Through a GI approach Ware can pursue construction projects that promote multiple community benefits. Such a project might involve an enhanced streetscape that not only improves the roadway, but provides for stormwater infiltration, adds areas for walking and bikeways and enhances aesthetic appeal. For such projects, interdepartmental coordination is essential. Working together, departments can identify how and where stormwater investments can occur to the best effect with investments in projects including streets and sidewalks, sanitary sewers, and parks. Moreover, projects incorporating GI provide a more visible outcome for public investments than underground grey pipe conveyance approaches to stormwater management.

While developing the Muddy Brook Resiliency Master Plan, a preliminary review of the Town's Bylaws was conducted. It became apparent a Stormwater Bylaw was completely missing from local code. The Working Group developed a bylaw and submitted it to the Conservation Commission, as the sponsor for the bylaw as well as the

stormwater authority under the bylaw, for review at their February 14, 2024, meeting. The Commission reviewed the proposed bylaw and made recommendations that were further discussed and approved at the April 10, 2024, meeting. The bylaw was reviewed by the Town Attorney, approved by the Selectboard and added to the 2024 Annual Town Meeting Warrant scheduled for June 10, 2024. The bylaw passed Town Meeting with over two thirds of the vote. The final Stormwater Bylaw is attached to this report in Appendix B.

MUNICIPAL GOOD HOUSEKEEPING

Municipal good housekeeping practices include a variety of activities that help reduce nutrients and solids entering waterbodies. These include routine practices such as street sweeping, catch basin cleaning, proper collection and removal of litter, avoid plowing snow into drainage areas and wetlands, maintenance of inlet/outlet structures and minimizing fertilizers and pesticide use on park and landscaped areas. The Town could offer leaf litter pick-up for residents, if not already offered, to ensure they do not blow leaf and landscape waste into the Brook, Snow Pond, wetlands, or tributaries.

HOMEOWNER POLLUTANT MANAGEMENT

Pollutant reduction is not just a Town obligation, every homeowner has a responsibility to ensure water leaving their property does not adversely affect other properties or our natural resources. The load reductions required to improve and protect Muddy Brook and surrounding habitat cannot be accomplished without individual landowner stewardship. Shoreland property owners are in a unique position where their property can provide some of the most critical features to reduce the impact of nutrients, sediments, moderate soil and water temperatures, and maintain habitat to support native wildlife. Some strategies implementable by individual homeowners include:

- For shoreland or wetland abutting properties, create and maintain substantial buffers along the shoreline (25 feet or greater depending on slope). This provides habitat, infiltration of stormwater and attenuation of pollutants. Encourage old growth trees and overhanging vegetation at the shoreline. This also makes properties less attractive to geese and other waterfowl that contribute TP and bacteria to the pond.
- Capture and infiltrate water around your home using rain gardens, dry wells, impervious pavers, and other techniques.
- Store, intercept and/or divert stormwater to places where pollutants can be reduced. Some examples include vegetated swales, rain barrels and water bars.
- Inspect and pump septic systems regularly. Do not use additives, do not flush bulky items and do not pour toxic materials down your drain. Substitute baking soda and borax for cleaners containing chlorine.
- Ensuring lawn care companies use non-phosphate fertilizers and minimize use of pesticides.

EDUCATION AND OUTREACH

Watershed outreach campaigns are intended to increase resident's understanding of activities in the watershed that have the potential to harm the lake. They are also used to inform people of steps they can take to improve conditions and prevent impacts. Activities could include:

- Update & maintain the Town webpage designed for Muddy Brook Protection regularly;

- Invite speakers to present topics via webinars or in person events (e.g., invasive species, responsible lake front living, controlling stormwater, septic system maintenance, etc.);
- Produce handouts and flyers to include with tax bill or other Town-wide mailings;
- Establish a Watershed Association or increase collaboration with the Chicopee 4 Rivers Watershed Council for future watershed monitoring efforts; and
- Request that the Water Department, Cemetery Commission and Parks Department post educational materials on signs or kiosks in parking areas. Insist that they place signage to educated residents on proper dog waste disposal, littering.

Furthermore, working with neighborhood organizations to help local property owners understand the benefits of on-site stormwater management. This will help build a knowledgeable constituency that can advocate for such "resiliency" expenditures on local public projects, as well as get property owners thinking about how they can manage problems with better stormwater management. For example, many homes and businesses have been developed so that gutter downspouts deliver flows from roof tops to driveways that slope to the streets. Water ultimately drains to the street and moves along the curb to nearby catch basin drains. With the cold of winter, these flows can create icy conditions on driveways. As people recognize the personal benefits of such stormwater improvements on their properties, including rehanging gutters so that flows move to an area of the property where rainfall can soak into soils, there is a greater likelihood of improvements. Offering a mini grants program to homeowners for stormwater retrofits can be a great way to advance both learning and engagement on stormwater management.

LAND USE PROTECTION AND ZONING REGULATIONS

A large amount of land in the upper watershed is owned by the Commonwealth and is in forested, undeveloped condition. It is important to preserve this space as any development will increase the nutrient loading of the Brook, even low impact development will have some effect. If properties identified in chapter 3 come up for sale, the Town should consider purchasing the property to reduce the risk of the land being developed and generating pollutants. Also, putting lands under conservation easements is a recommended protective measure. A strong relationship exists between land use type and pollutant generation, with developed impervious lands being the most destructive. Preserving undeveloped lands is the highest priority to ensure long-term protection and resilience against climate changes. Appropriate Town-wide ordinances could include tree or vegetation cutting limitations, requirements to establish buffer zones, increase set back requirements, septic system ordinances for maintenance and inspections. Vermont's Shoreland Protection Act is a very good example.

DEVELOPER INCENTIVES

Developer incentives include expedited permitting, decreased fees, zoning upgrades, reduced stormwater requirements, and other benefits to developers who plan to use green infrastructure. Developer incentives go beyond single-site improvements and can have large-scale impacts. Municipalities can encourage developers and homeowners to incorporate Low Impact Development (LID) or Green Infrastructure (GI) practices by offering incentives for both planned and existing developments. On existing developments, incentives can be used to encourage landowners to retrofit their sites with LID practices. Incentives also can be used to entice developers to use green infrastructure practices when they are planning, designing and constructing their projects. The four

most common types of local incentive mechanisms are fee discounts or credits, development incentives, best management practice installation subsidies, and awards and recognition programs.

STORMWATER FEE DISCOUNT OR CREDIT

Municipalities often charge a stormwater fee based on the amount of impervious surface area on a property. If a property owner decreases a site's imperviousness or adds LID practices to reduce the amount of stormwater runoff that leaves the property, the municipality will reduce the stormwater fee or provide a credit that helps the landowner meet a water quality performance or design requirement.

DEVELOPMENT INCENTIVES

Municipalities can offer incentives that are only available to a developer who uses LID practices. Some municipalities will use these incentives to encourage development on targeted sites, such as brownfields. For example, municipalities might offer to waive or reduce permit fees, expedite the permit process, allow higher density developments, or provide exemptions from local stormwater permitting requirements for developers that use LID practices.

REBATES AND INSTALLATION FINANCING

To offset costs, municipalities might offer grants, matching funds, low-interest loans, tax credits or reimbursements to property owners who install specific LID practices or systems. For example, some communities offer programs that subsidize the cost of rain barrels, plants and other materials that can be used to control stormwater.

AWARDS AND RECOGNITION PROGRAMS

Some municipalities hold LID-design contests to encourage local participation and innovation. Many communities highlight successful LID sites by featuring them in newspaper articles, on websites and in utility bill mailings. Some also issue yard signs to recognize property owners who have installed LID. Recognition programs can help to increase property values, promote property sales and rentals, and generally increase demand for the properties.

FUNDING SOURCES

Assessing conditions and implementing BMPs will require financial and technical assistance. Watershed management is viewed favorably in funding circles, especially if it involves non-point source controls, environmental justice communities and climate adaptation. Some funding sources include:

- **Section 319 Non-Point Source Control Program** for prevention, control, and abatement of nonpoint source pollution https://www.mass.gov/info-details/grants-financialassistance-watersheds-water-quality

- **Local Acquisitions for Natural Diversity (LAND) Grant** offers funding to acquire interests in land that will be used for conservation and passive recreation purposes https://www.mass.gov/how-to/apply-for-a-local-acquisitions-for-natural-diversity-land-grant
- **Culvert Replacement Municipal Assistance Grant Program** offers assistance to replace undersized, degraded or poorly placed culverts for ecological improvements https://www.mass.gov/how-to/culvert-replacement-municipal-assistance-grant-program
- **MVP Action Grants** offers assistance to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts https://www.mass.gov/service-details/mvp-action-grant
- **MVP 2.0 Grant** helps communities to build off of and fill in gaps from the original MVP Planning Grant (1.0) process. In particular, MVP 2.0 focuses on addressing root causes of social vulnerability and moving from planning to implementation https://www.mass.gov/info-details/mvp-20
- **Drinking Water Supply Protection Grant** offers funding to protect and conserve the quality and quantity of public drinking water supply sources in the Commonwealth. It can also be used for the acquisition of land in DEP approved drinking water supply protection areas or, if a planned future wells or intakes, estimated protection areas https://www.mass.gov/how-to/apply-to-the-drinking-water-supply-protection-grant-program
- **Massachusetts Land and Water Conservation Fund Grant** offers funding for acquiring land for conservation or recreation purposes, building a new park, renovating an existing park, or doing trail work https://www.mass.gov/how-to/apply-to-the-massachusetts-land-and-water-conservation-fund-grant-program
- **Landscape Partnership Grant** offers funds to protect contiguous, large-scale landscapes necessary to sustain the integrity and resiliency of ecosystems and viability of local farms and forest economies, to enable projects that stretch beyond the scope of other state grant programs, standard spheres of operation, and involve cooperation of multiple actors and to support the Executive Order 569, which calls for state government to adapt to climate change and build a more resilient Commonwealth. For Hampshire County the minimum acreage required is 250 acres https://www.mass.gov/how-to/apply-for-a-landscape-partnership-grant
- **Parkland Acquisitions and Renovations for Communities (PARC) Grant** can be used by municipalities to acquire parkland, build a new park, or to renovate an existing park https://www.mass.gov/how-to/apply-to-the-parkland-acquisitions-and-renovations-for-communities-parc-grant-program
- **Massachusetts Environmental Trust Grant**s offers funding for protection and conservation projects https://www.mass.gov/met-projects-and-grant-awards
- **Surface Transportation Program** under the Interstate Transportation Efficiency Act offered for roadway improvements, including environmental enhancements. https://www.mass.gov/service-details/funding-considerations
- US Department of Agriculture Programs such as **the Resource Conservation and Development Program** and the **Wildlife Habitat Incentives Program** https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives
- **Community Septic Management Program** offers financial assistance and incentives to communities and system owners. https://www.mass.gov/info-details/water-resources-grants-financial-assistance#the-community-septic-management-program

APPENDIX A: MAPS

- Map 1: Muddy Brook Watershed
- Map 2: Bordering Vegetated Wetlands
- Map 3: Vernal Pools
- Map 4: Floodplain
- Map 5: NHESP Priority Habitat for Rare & Endangered Species
- Map 6: BioMap 3 Core Habitat & Critical Natural Landscape
- Map 7: Environmental Justice Block Groups
- Map 8: Risks & Threats
- Map 9: Public Water Supply & Aquifers
- Map 10: Muddy Brook Proposed BMP Locations & Prioritization
- Map 11: Open Space & Recreation Lands
- Map 12: Snow Pond Invasive Species Map (Density & Composition)

APPENDIX B: STORMWATER BYLAW

APPENDIX C: WORKING GROUP MEETINGS (AGENDAS, MINUTES & SIGN-IN SHEETS)

- September 14, 2022
- October 17, 2022 (Planning Board Presentation)
- November 15, 2022
- August 17, 2023 (Planning Board Presentation)
- September 12, 2023
- November 30, 2023
- January 11, 2024
- March 14, 2024
- April 11, 2024
- May 9, 2024
- June 6, 2024 (Planning Board Presentation)
- June 13, 2024
- June 18, 2024 (Selectboard Board Presentation)

APPENDIX D: STAKEHOLDER INTERVIEWS

- Tom Barnes, Vice-Chair Conservation Commission
- Geoffrey McAlmond, DPW Director
- John Piechota, Parks & Recreation Director
- Jim Martinez, Fire Chief & Emergency Management Director
- Keith Davies, Chicopee 4 Rivers Watershed Council
- Bill Zini, Chair Hardwick Conservation Commission

APPENDIX E: WATERSHED CELEBRATION

- Sign-In Sheet
- Muddy Brook Watershed Pledge
- Ware River New Article – Thursday May 23, 2024