A Climate Resilience Plan For Plainfield, MA

Town of Plainfield

Hope Matis ~ Jack Rosenwinkel ~ Rachel Tanzer

The Conway School

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Acknowledgments

The Plainfield Climate Resilience Plan was prepared with help and suggestions from many groups and individuals. Special thanks are owed to the Plainfield Core Team for their support and guidance throughout the course of this project, as well as members of the Plainfield community who participated in stakeholder and community engagement meetings. In particular, we would like to recognize the following groups and individuals for their invaluable feedback: Peg Keller, Erik Burcroff, Ed Stockman, Tim Walter, Jerry Little, Howard Bronstein, Walt Jennings, David Alvord, Jennifer Lee, Bob Mellstrom, Ellen Dupont, Energy Committee, Agricultural Commission, Conservation Commission, and Tree Alliance.

We are also grateful to the Conway School faculty and staff for their support. Thank you!

This Plan was prepared with funding from the Massachusetts Executive Office of Energy and Environmental Affairs.

CENTERING SOCIAL JUSTICE IN CLIMATE ACTION

Climate resilience is best achieved through a diversity of tactics and this includes a diversity of people, cultures, and perspectives. Natural resource exploitation is deeply rooted in white supremacy, and has helped lead to the current climate crisis. Land justice is an essential component of healing the land and supporting healthy and resilient landscapes, ecosystems, and communities. Land justice seeks healing across all systems, and requires creative solutions that are built on respect. It begins by acknowledging the inequities and harms perpetuated by settler colonization, and must center the voices of those most oppressed to ultimately build collective resilience.

Implementation of this plan must involve local native peoples, including tribes who have been forcibly removed from their traditional lands, and other communities most oppressed by settler colonization. The Tribal Climate Adaptation Menu provides a framework for tribal climate resilience; this framework offers non-native people tools for respectfully approaching sovereign nations; however, it is critical to know that each tribe is different, and may or may not agree with the principles outlined in that menu. It is also important to understand that tribes are sovereign nations, and have varying relationships with one other. This Climate Resilience Plan has not been reviewed nor endorsed by any local tribal nation including the Mohican or Nipmuc tribes.

Executive Summary

The impacts of human-caused climate change are already being felt across the globe. More extreme and variable temperatures, storms, and droughts are straining communities, livelihoods, ecosystems, and biodiversity. Climate change forecasts only expect these impacts to increase in severity over the coming decades. Recognizing the current and future risks posed by climate change, the people of Plainfield, Massachusetts, have come together to begin pursuing pathways towards community resilience. Their efforts have resulted in the development of a *Municipal Vulnerability Preparedness Plan* (2018), a *Hazard Mitigation Plan* (2019), and (herein) a Climate Resilience Plan.

The purpose of this Climate Resilience Plan (CRP) is to serve as a call to action: to imagine, restore, and create resilient relationships between the community and the natural and built systems that make up the landscape now known as Plainfield. This Plan should serve as a guide for staff, volunteer board members, and community members to understand how land use decisions and stewardship practices can contribute to a climate resilient future. Funding for this project was provided by a grant from the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) in conjunction with matching funds from the Town of Plainfield.

The CRP highlights the importance of supporting both ecosystem function and local economies by protecting the important habitats needed to sustain biodiversity and promoting healthy forest management practices. To ensure the health of its waters and increase the town's flood resilience, it is particularly important to protect the forests and natural vegetation immediately surrounding streams and wetlands. In protecting these critical ecosystem functions and services it is also necessary for the community to stress equity in land access and ownership. While permanently protecting land for conservation is often an effective way to preserve ecosystem services, it can also cause undesirable economic and social impacts such as reduction in tax revenue for the town, reduction in economic value for the landowner, and barriers to access for sovereign indigenous peoples and/or the general public.

Power outages and energy resilience are a major concern in the community and the thoughtful incorporation of renewable energy may play an important role in reducing fossil fuel use and improving the reliability of energy supplies in town. However, the use of large-scale solar photovoltaics presents a significant potential conflict with other land uses in Plainfield. It will be important to establish to what extent the community wants to or can feasibly have large-scale solar as part of its energy vision. In the meantime, existing solar regulations can be amended to provide increased protection to critical natural resources, and all possible steps should be taken to address energy efficiency and preparedness to reduce the overall demand and improve residents' ability to cope without grid power.

Other forms of development, such as commercial or residential, may also present the community with difficult land use decisions. Although it may be hard to imagine today, it is likely that Plainfield will experience increased development pressure in

the future, and should act now to have appropriate guidance in place to minimize the potential impacts on valuable natural resources and the visual character of the town. If possible, development that does occur should improve community resilience by promoting strong social connections and access to vital support systems.

Through research, analyses, and community engagement, 14 major strategies for improving climate resilience were developed in this Plan:

- Make land justice a top priority
- Protect biodiversity and important habitat
- Manage forests for climate resilience
- Protect riparian forests and vulnerable waterways
- Guide new infrastructure and development with water in mind
- Identify and reduce contaminants in surface waters and groundwater supply
- Implement strategies from the MA Smart Growth / Smart Energy Toolkit to preserve agricultural land
- Preserve and enhance Plainfield's agricultural capacity
- Promote small-scale local food production
- Plan for energy efficiency and decarbonization
- Build with energy efficiency and renewables in mind
- Decrease vulnerability of existing energy infrastructure
- Plan for Smart Growth
- Incorporate resilience into community space projects

A more detailed list of all recommendations from this plan can be found on pg. 90.

Plainfield sits at the top of two watersheds and contains extensive forests that are part of larger regional ecosystems. Therefore, it is in an excellent position to participate in cross-boundary study and collaboration at the watershed or even regional scale. These collaborations should be particularly encouraged around food and energy systems as well as existing and developing initiatives in forest management for climate change and carbon mitigation.

Photo Credit: Hugo Bundy

Introduction

PURPOSE AND GOALS

The purpose of this Climate Resilience Plan (CRP) is to serve as a call to action: to imagine, restore, and create resilient relationships between the community and the natural and built systems that make up the landscape now known as Plainfield. This Plan should serve as a guide for staff, volunteer board members, and community members to understand how land use decisions and stewardship practices can contribute to a climate resilient future. Funding for this project was provided by a grant from the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) in conjunction with matching funds from the Town of Plainfield.

After being awarded the grant in 2021, the Town approached the Conway School to assist in the development of the Climate Resilience Plan (CRP). In its grant application to the EEA, the Town had acknowledged the critical importance of ecological systems to the resilience of the communities within them and the role of land use decisions in supporting thriving communities.

Initial guiding questions in the Town's grant application included:

- What important natural resources should be protected that currently are not?
- How can private property owners be engaged in sustainable land use practices?
- What are current and potential future impacts to water quality and potential mitigation strategies?
- What roles do trees and forests play in healthy ecosystems and a sustainable future?
- What recommendations of the previous plans (Municipal Vulnerability and Hazard Mitigation Plans) can be moved closer to implementation? Where are there synergies between the plans and the CRP?
- How should renewable energy, and particularly solar energy, be incorporated into the landscape?

These questions reflect a need for a comprehensive understanding of landscapes, ecosystem services, watersheds, community, infrastructure, and the spatial requirements of these systems when planning for climate change. Therefore, the CRP seeks to identify:

1. The systems that the community believes will increase climate resilience in Plainfield
2. The landscape requirements for these systems
3. Whether there are competing land needs, and if so, the potential tradeoffs
4. How the community's relationship with and stewardship of the landscape might need to change to improve climate resilience

Plainfield Pond

Plan Background

The Town of Plainfield covers 21.3 square miles at the far northwest corner of Hampshire County in western Massachusetts. Plainfield is part of the Hilltown region of western MA, a grouping of rural communities often defined by their rolling hills and vast forests. While the population of Plainfield is fairly small at only around 650 people, the residents are highly active in their local community and have a propensity for forward thinking. In 2018, the community came together in response to a series of severe weather events to begin thinking about the risks posed by climate change. The town engaged in Massachusetts' Municipal Vulnerability Preparedness (MVP) Program to begin identifying and addressing vulnerabilities to climate change.

Plainfield used the MVP program as an opportunity to consolidate several ongoing efforts by many of its Town Boards and Committees. The Town created a joint team that worked with the Pioneer Valley Planning Commission (PVPC) to complete an assessment and create a *Municipal Vulnerability Preparedness Plan* in 2018 as well as the Town's first *Hazard Mitigation Plan* (HMP). The top hazards identified by these assessments included:

- Severe winter weather
- Other severe weather types (e.g., high rainfall, high wind)
- Invasive species and vector-borne disease
- Extreme heat and cold

Primary areas of concern included utilities and transportation infrastructure (e.g., electrical, roads, culverts), natural resources, human and social factors (e.g., communications, aging and vulnerable populations), and the built environment (e.g., historic buildings, aging housing stock) (Slotnick et al., 2018).

A list of recommendations to improve Plainfield's resilience to climate change effects was generated in these plans that included actions related to infrastructure upgrades, transportation, communications strategies, emergency management, energy distribution systems, water management, and open space and land management. The broad scope of these plans shows that planning for climate change is complex and spans many interrelated elements.

After the completion of the MVP program, Plainfield leadership sought a way to continue the interest and momentum generated during those activities. A large subset of the recommendations from the HMP and MVP plan touched on how the relationship of physical elements of the landscape (such as forests, roads, streams, farms, and houses) can contribute to or detract from the community's overall resilience. The Town realized it would benefit from a closer examination of these relationships in order to make informed land use decisions in its planning for climate change. It sought a plan that would build upon the HMP and MVP, but with a particular focus on resilient land use practices; hence, the idea for a Climate Resilience Plan was born.

Massachusetts Municipal Vulnerability Preparedness (MVP) Program

The Commonwealth of Massachusetts supports efforts to improve community climate resilience through the Municipal Vulnerability Preparedness (MVP) program, which is administered by the Executive Office of Energy and Environmental Affairs (EEA). This program provides support for communities in Massachusetts to prepare vulnerability assessments. Communities that complete the program become eligible for MVP Action Grants to implement recommendations made in their assessment reports (EEA, 2022).

COMMUNITY VOICE

Community Engagement

A vision for Plainfield's landscape should reflect the values and goals of the community and serve to guide actions to achieve those goals. The CRP is a public document and was informed by community participation throughout its development. During February and March 2022, a team of graduate students from the Conway School facilitated a series of calls with individual stakeholders and focus groups as well as a larger public meeting held via Zoom, which drew approximately thirty-five attendees from the community. The stakeholders represented a variety of community groups and Town boards and committees and discussed the major challenges, assets, and limitations that Plainfield is facing.

Community Perspective

The stakeholder meetings revealed several recurring themes regarding how Plainfield residents view their community and its potential vulnerabilities. Residents value the beauty and functionality of their environment and would like to see these natural resources preserved; however, increasing the amount of conserved land in town directly reduces tax revenue for a municipality that is already struggling with small budgets and overextended volunteer leadership. There are broad concerns about climate change and the need to mitigate greenhouse gas emissions through reducing reliance on fossil fuels in energy and transportation. There are also local concerns about the vulnerabilities of the community's infrastructure and population to severe weather events, including sheltering and caring for people during outages and other emergencies, communications and access, and food security.

Many of the concerns stated during community outreach were similar to those expressed during the development of the Hazard Mitigation Plan. As part of this CRP development process, the recommendations from the previously completed plans were evaluated for their effectiveness and potential synergy with the CRP. Many of the proposed actions in the Municipal Vulnerability Preparedness assessment and HMP are relevant to land use planning and decision-making and have been included and/or revised as recommendations within this Plan. The Plainfield CRP approach may contribute to efforts being pursued in other small rural communities eager to address climate resilience.

Community Concerns

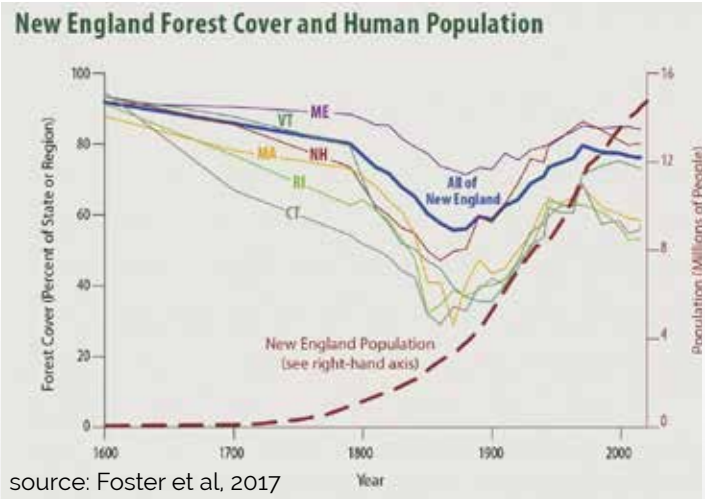
- Increasing severe weather
- Potential loss of forests
- Equity in land access and ownership
- Water quality in Plainfield Pond
- Road salt impacts
- Potential loss of agricultural land
- Road conditions
- Emergency vehicle access to isolated homes
- Dependence on fossil fuels
- Energy independence during outages
- Conservation impacts on tax rolls
- Lack of funds and staff

PLAINFIELD'S LANDSCAPE, THEN AND NOW

20,000 years ago, the area now known as Plainfield was under a dense sheet of ice. The Laurentide glacier, as it is referred to, was a mile thick in places and covered the northern half of North America. The climate of that time was much colder than today, but it was beginning to warm and the ice was melting.

When the ice retreated from Western Massachusetts, plants and animals began migrating back to the landscape, along with people. This land has been inhabited by humans for thousands of years. It is the ancestral homeland of many indigenous people from communities such as the Nipmuc, Pocumtuck, Wabanaki, and Mohican people. Despite genocide and forced removal associated with settler colonization, tribal communities continue to demonstrate resilience and care for this landscape.

Since European colonization in the 17th century and the establishment of town boundaries, Plainfield's landscape has undergone substantial change. Arrival of Europeans and the forced removal and assimilation of indigenous people drastically changed the relationship between people and the landscape. One of the most striking changes was the widespread clearcutting of forests for timber and to make room for agriculture.



source: Foster et al, 2017

By the 1800s, Plainfield was a thriving agricultural community, mainly producing sheep and leather. Its streams supported a large number of mills, particularly sawmills and gristmills, some of which remained in use for more than one hundred years. The population peaked at approximately 1,000 in the mid-1830s, then subsequently declined as cheaper mutton and leather prices undermined the agricultural industry in town, reaching a low of about 230 in 1950. The decline of agriculture brought with it a regeneration of forests on Plainfield's landscape. Since 1950, the population has been slowly increasing, reflecting statewide trends of growing population and human development that once again is leading to a loss of forests.

Today Plainfield's landscape is composed of small farms, ponds, streams, sparse development, and large expanses of forest. In community meetings held in preparation for this Plan, many Plainfield residents remarked on the beauty of the landscape. Some have families who have lived here for generations while others moved to Plainfield, feeling drawn to the forests, hills, and streams. The value and importance that is placed on stewarding the landscape into the future was clearly stated in these meetings.

The history of shifting landscapes in Plainfield reveals the dynamic relationship between people, climate, and land. It also leads to a perspective of Plainfield's landscape today as part of a continuum of this history, rather than existing in static form. While Plainfield's landscape will continue to be shaped by people and climate, the advent of human-caused climate change will bring about a rate of change unprecedented in this long history.


West Mountain looking to Plainfield Pond
Photo Credit: Plainfield Historical Society

CLIMATE CHANGE IN THE NORTHEAST

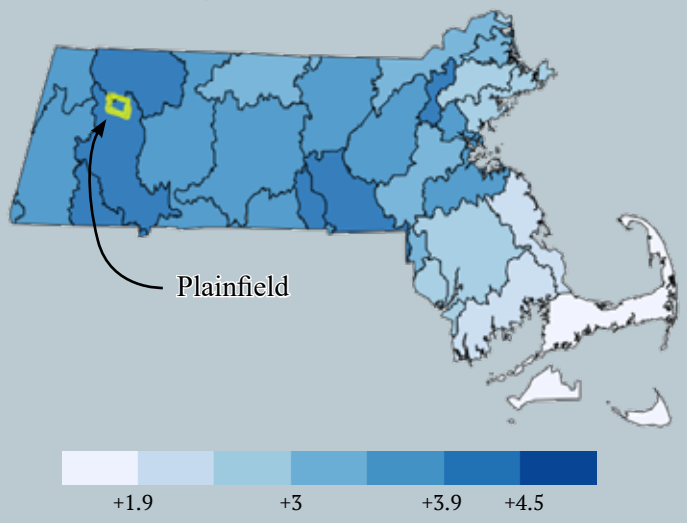
Climate change refers to long-term shifts in temperatures and weather patterns (United Nations). These shifts may occur naturally, but scientists now agree that human activities, principally the burning of fossil fuels, have become the primary driver behind climate changes observed over the last two hundred years. Burning fossil fuels generates carbon dioxide, which is referred to as a greenhouse gas (GHG) since it helps to trap heat in the atmosphere, warming the planet. While the primary GHGs (carbon dioxide and methane) are naturally occurring, they are being added to the atmosphere at an unprecedented rate by human activity and are presently at their highest concentrations in two million years (United Nations). This is exacerbated by a parallel increase in land clearing, which removes vegetation that can absorb carbon dioxide from the atmosphere.

Climate change effects are already being seen in many places around the globe. The northeastern United States is experiencing an increase in average temperature and an increase in the frequency and intensity of severe weather events, interspersed with periods of drier conditions (U.S. Climate Resilience Toolkit, 2020). This can result in a variety of threats to communities, including human health and safety, economic stability, and human migration patterns. For example, the seasonality of the Northeast is a major contributor to the regional identity and helps drive rural economies. Warming temperatures will cause shifts in seasonal patterns. Less distinct seasons with milder winters and unpredictable precipitation are already altering ecosystems and environments in ways that adversely affect tourism, farming, and forestry. Rural economies and livelihoods are at risk from further changes to forests, snowpack, water resources, and other important elements (Dupigny-Giroux et al., 2018).

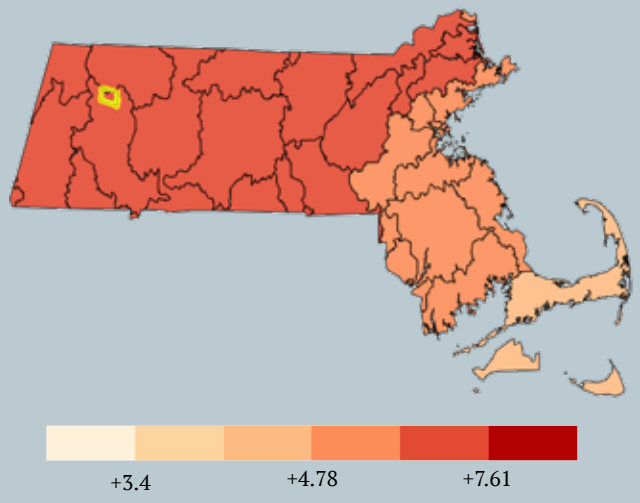
ResilientMA.org provides data and interactive mapping on climate change projections for the Commonwealth as well as specific counties and major river basins within Massachusetts, based on simulations from available climate change models (n.d.). It is estimated that by the 2050s, mean annual temperatures in Massachusetts will rise by between three and six degrees Fahrenheit, with more days per year above 90 and even 95 degrees and an increase in total annual precipitation of two to thirteen percent. Much of this increase will happen in the winter, with precipitation estimated to increase by up to 21 percent (ResilientMA.org).

In addition, increasingly frequent and more severe weather events such as thunderstorms, hurricanes, ice storms, and blizzards can threaten human safety and cause environmental harm through power outages, extreme temperatures, flooding, and damage to human infrastructure and natural systems. Plainfield has experienced a string of such events in the past ten to fifteen years, including a major ice storm in 2008, Tropical Storm Irene in 2011, a severe blizzard in 2011, and varied other thunderstorms, wind events, extreme cold, and drought.

Projected change in inches of annual precipitation by 2050. Shown by watershed. RCP 8.5 model.



Projected change in average temperature (˚F) by 2050. Shown by watersheds. RCP 8.5 model.



Maps From ResilientMA.org

Defining Resilience

Resilience is a term used in many different contexts and given many different definitions. To establish the purpose of a climate resilience plan, it is important to clarify which definition of resilience is being used and why.

Commonly, the term "resilience" is used to refer to a system's ability to return to a state of equilibrium or normalcy after a disruption. This definition, known as **engineering resilience**, often underlies many climate adaptation strategies. For example, coastal communities experiencing erosion from sea level rise will sometimes invest in beach nourishment practices—the process of placing additional sand from outside sources on their shores. Under the engineering resilience definition, such a community would be considered resilient because of its ability to "bounce back" by restoring the conditions of its beach (Funfgeld, 2012).

However, this definition of resilience is limited in that it does not question the desirability of "normal" or the long-term implications of trying to maintain "normal" conditions. The restored beach from the example above is just as vulnerable to erosion and flooding as it was before. This ideology underlies planning that overemphasizes short-term responses to disturbances, rather than a long-term vision that builds the capacity to evolve and adapt to a changing world.

In contrast, a newer conception of resilience, known as **socio-ecological resilience**, challenges the entire notion of equilibrium. It instead suggests that resilient systems require constant transformation and evolution in response to disturbance. Socio-ecological resilience "is about people and nature as interdependent systems" and requires recognition of this dynamic relationship (Folke, 2010). The ability to continually adapt and transform is particularly important in the context of climate change due to the variability and unpredictability of its long-range impacts.

Therefore, increasing a community's climate resilience involves increasing both the functionality of its natural, social, and built systems as well as the flexibility for them to evolve. Specific strategies or recommendations for increasing resilience may be based on one of these definitions more than the other, often depending on whether the strategy is designed to address acute, short-term issues or more gradual long-term changes.

ORGANIZATION OF THE CLIMATE RESILIENCE PLAN

This Plan presents an evaluation of the composition of Plainfield's landscape and describes elements and systems that contribute to climate resilience in Plainfield. The CRP identifies five primary elements of importance in Plainfield's landscape: forests and other critical/unique habitats, water resources, energy systems and solar development, agriculture and food systems, and patterns of human development. For each element, the Plan sections provide the following:

- Detailed analysis of the conditions existing in Plainfield today
- How the system contributes to (or impacts) climate resilience in the community
- Implications of climate change for the system and/or its components
- Recommendations for improving climate resilience, with discussion of potential resources and/or challenges to implementation

The Plan concludes with a discussion of other factors or challenges that may be relevant as the Town pursues its climate resilience goals. A summary of all recommended strategies and actions may be found on Page 90.

Chapter 2

Ecosystems & Biodiversity

"A climate resilient site is one that maintains species diversity and ecological function even as it changes in response to a changing climate" (Anderson et al., 2021).

SECTION SUMMARY

Increasing awareness of the interconnectedness of people and ecosystems can lead to more compassionate and sustainable relationships between people and ecosystems (Ritter and Dauksta, 2013). Fostering relationships between people and forests is therefore a critical part of building climate resilience. In the context of Plainfield, stakeholders continue to demonstrate passion for the forests, and look to uphold this legacy and support their enduring future.

This chapter describes the terrestrial ecosystems in Plainfield, how climate change might influence ecosystem composition and health, the roles ecosystems play in climate resilience, and how the Town could take measures to ensure that ecosystems remain healthy and resilient long-term. This chapter also includes analyses that serve to identify specific natural areas to prioritize for conservation, a discussion of the pros and cons of conservation restrictions in Plainfield, and several alternatives to traditional conservation restrictions. Ultimately, this chapter aims to provide the Town with recommendations focused on protecting ecosystem health based on ecosystem composition, climate resilience, and feasibility of implementation.

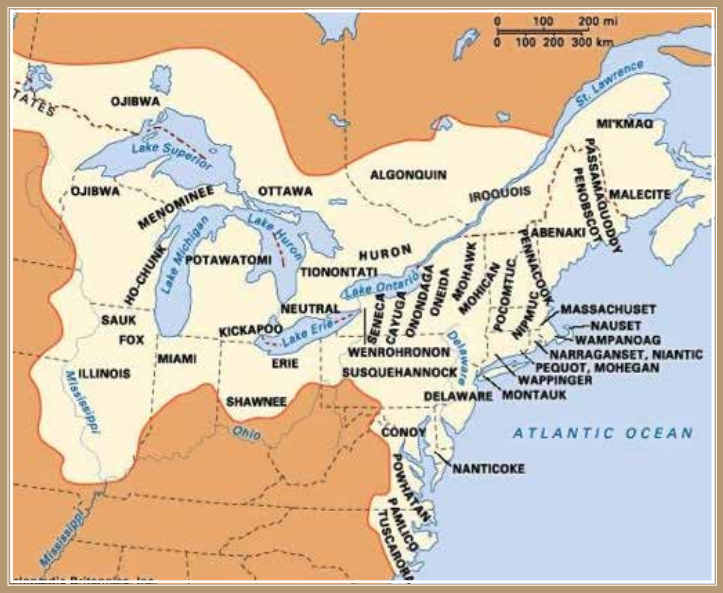


Photo Credit: https://www.maplenation.org/

Maple Nation

The greater northeastern bioregion is known as Maple Nation to many indigenous tribes who have long stewarded these forests. This region holds great spiritual, cultural, and medicinal value to indigenous people (Maple Nation).

The sugar maple is just one example of a cultural keystone species that is at elevated risk of decline with climate projections (see page 26). Other cultural keystone plant species native to this region include white pine, black ash, and sweetgrass.

While rising temperatures may cause a steady decline in sugar maples in this area—the southern end of its range—there are certain locations where it is likely to persist due to cooler microclimates and other geophysical characteristics For example, sugar maples on northern facing slopes, at higher elevations, and on moister sites are predicted to exist longer here.

In order to understand the threats that climate change poses to local ecosystems and actions that can be taken to mitigate those effects, it is necessary to first take stock of the habitats that currently exist. This section describes the predominant habitats in Plainfield today as well as existing forest management practices and land that is currently in conservation.

Forests

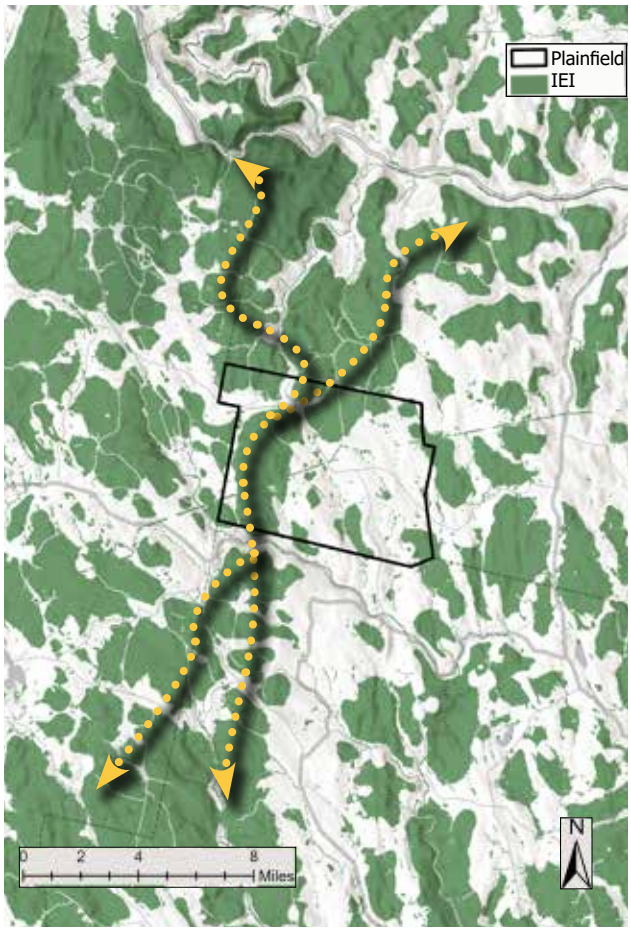
Forest blankets most of the Northeast, covering 28 million acres of land (or 86% of the landscape) (Anderson et al., 2021). A macrogroup is a broad classification of forest type based on a combination of plant species and their growth forms, biogeographic differences, geophysical traits, and disturbance regimes (Gawler, 2008). Plainfield's forests are largely classified in the **Northern Hardwoods and Conifer Macrogroup**. This macrogroup is known for its annual death and rebirth cycle thanks to deciduous tree canopy, resulting in iconic fall color and a diversity of vegetation due to the region's varied topography and geophysical characteristics (Anderson et al., 2013). Plainfield sits at the southern edge of this group, in a transitional zone that will play a critical role in allowing for species adaptation as temperatures rise (see page 18).

Contiguous Forests

A corridor of contiguous forest runs through Plainfield, linking regional forested land from the north and south. This largely unfragmented network of forest exists on both public and private lands. Map 2-1 illustrates areas that rank high on the UMass Index of Ecological Integrity (IEI) for connectivity. In Plainfield, specifically, this contiguous forest is concentrated in the West Mountain region and is largely owned by Mass Audubon, along with a few publicly-owned and private parcels (see page 23). Sizable areas of contiguous forests are able to sustain populations of larger animals like black bears and moose, which are frequently sighted by residents.

Protecting contiguous forest is a widely agreed upon strategy for supporting forest health and retaining species diversity. Forest habitat supports an array of terrestrial species ranging from large canopy trees, understory plants, and large mammals to fungi and soil microbes. Furthermore, fragmentation can lead to entire species decline. What may seem like a minor fragmentation–such as a road or a trail–may be impassable for some species of concern such as wood turtles and spring salamanders.

Beyond animals, intact corridors are also essential for vegetation to migrate. Ecosystems are dynamic; species are always moving and adapting to changing conditions, which, over time, alters forest composition. Allowing this movement and species adaptation is important in building overall forest resilience as climate change impacts intensify (see page 26).



Map 2-1: Index of Ecological Integrity (IEI)

Unfragmented forest lands that are climate resilient and support regional biodiversity by connecting and protecting other habitats (UMass CAPS 2020).

Habitat Categories

Plainfield is home to a diverse range of habitats that have the potential to support at least 43 identified species of concern, according to the Explorer PRO tool developed by NatureServe (available through their website). Habitat refers to the physical and biological environments providing food, shelter, and other needs of particular species (Anderson et al., 2013). This section describes existing regional and local habitats, which are broken down into three categories below. Because forest covers the broadest range of conditions, matrix forests are discussed first, as part of the description of forested land in Plainfield.

Matrix Forest - dominant forest types that occupy large contiguous areas (generally >5,000 acres, under natural conditions). Other habitats can be nested within the matrix where there are variations in geophysical characteristics and/or disturbances.

Wetlands - Swamps, bogs, marshes, floodplains, and fens that form in annually flooded or permanently saturated conditions where water collects.

Patch Habitat - Terrestrial hotspots of species diversity, including rare and endangered plant species. These may include summits, cliffs, barrens, and dunes.

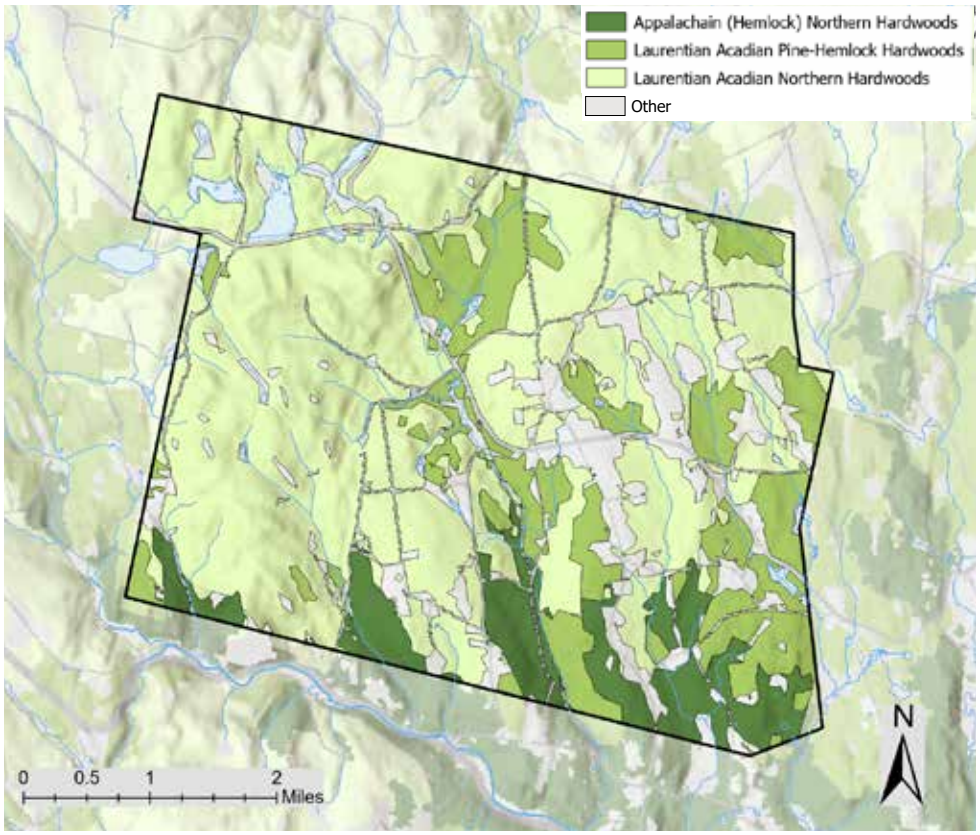
Forests of Plainfield

Northeastern regional forests can be broken down into 10 sub-categories which are referred to as **Matrix Forests** *(*Anderson, 2013). Three matrix forest types are found in Plainfield: Laurentian-Acadian Northern Hardwood, Laurentian-Acadian Pine Hemlock, and Appalachian (Hemlock)-Northern Hardwood.

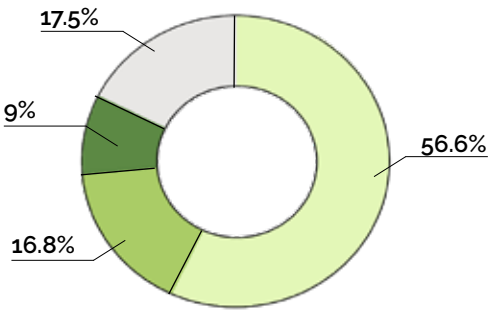
Map 2-2:

Matrix Forest Distribution in Plainfield

The majority of Plainfield is the Laurentian Acadian Northern Hardwoods matrix forest. The other two matrix forest types are transitional forest types.



Matrix Forest Distribution in Plainfield



Transitional forests play a key role in supporting species migration as temperatures rise and hardiness zones shift.

In Plainfield, the Laurentian-Acadian Northern Hardwood Forest is the dominant matrix forest present, accounting for nearly 7,710 acres–which is a little over half of town. The Laurentian-Acadian Pine-Hemlock-Hardwood Forest is the second most prevalent matrix forest type in Plainfield, making up 2,288 acres of town (16.8%). The Appalachian (Hemlock)-Northern Hardwood Forest type covers roughly 1,240 acres, or 9% of the town.

In summary, just over 75% of Plainfield is covered in forest, most of which is broadly categorized as Northern Hardwoods Forest. However, a more detailed breakdown of Plainfield's matrix forest composition shows that more than a quarter of town is covered in **transitional forest** types. This is significant because these forest types will aid in species migration from the south to the north, as temperatures continue to climb with climate change (see page 26).

Matrix Forest Types in Plainfield

Note: the following descriptions are general and not specific to Plainfield.

Barred Owls are residents found in Plainfield's forests.

Laurentian-Acadian Northern Hardwood Forest

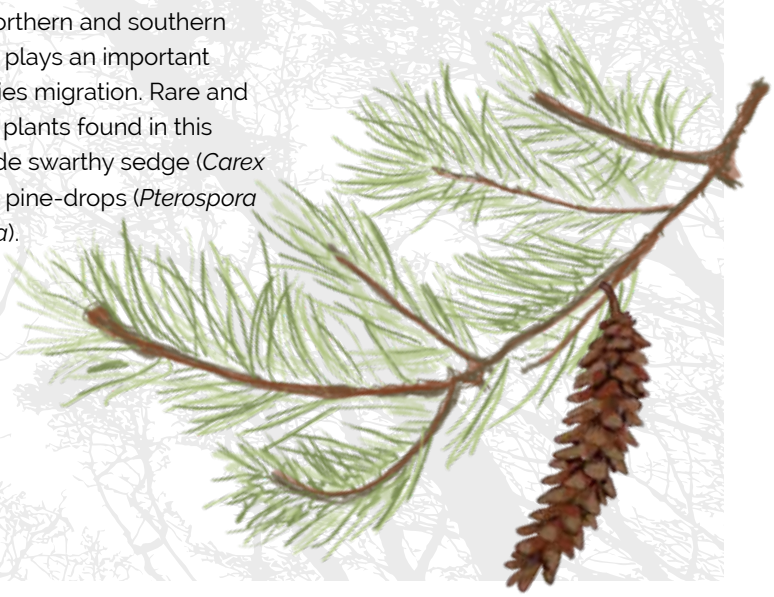
This forest includes typical canopy trees such as sugar maple, American beech, and yellow birch; other species include white ash, hemlock and red spruce. Characterized as an "ecological generalist," this forest is found in a range of settings; different geophysical characteristics create variations in species composition (Anderson, 2013). These forests host a variety of life–from large mammals like black bear and moose, to smaller animals such as spring salamanders and flying squirrels, to rare plants such as the Allegheny vine (Adlumia fungosa).

Laurentian-Acadian Pine Hemlock-Hardwood Forest

A mixed coniferous and deciduous forest with common tree canopy species including Eastern white pine, Eastern hemlock, red oak, and red maple. Other hardwoods such as sugar maple, beech, and birch also occur. Less common species include red spruce and balsam fir. This forest type is typically found in areas at mid-elevations with past disturbance regimes (i.e., deforested for agriculture). This is a transitional forest, meaning that it bridges northern and southern forests, and plays an important role in species migration. Rare and uncommon plants found in this forest include swarthy sedge (*Carex adusta*) and pine-drops (*Pterospora andromedea*).

Appalachian (Hemlock)-Northern Hardwood Forest

Another transitional forest type, similar in composition to the prior, but with more oak presence (Northern red oak and white oak), and other species at the northern end of their range such as tulip tree. It is known to host a variety of rare and endangered species including the Northern goshawk, Canadian warbler, and American ginseng (*Panax quinquefolius*).

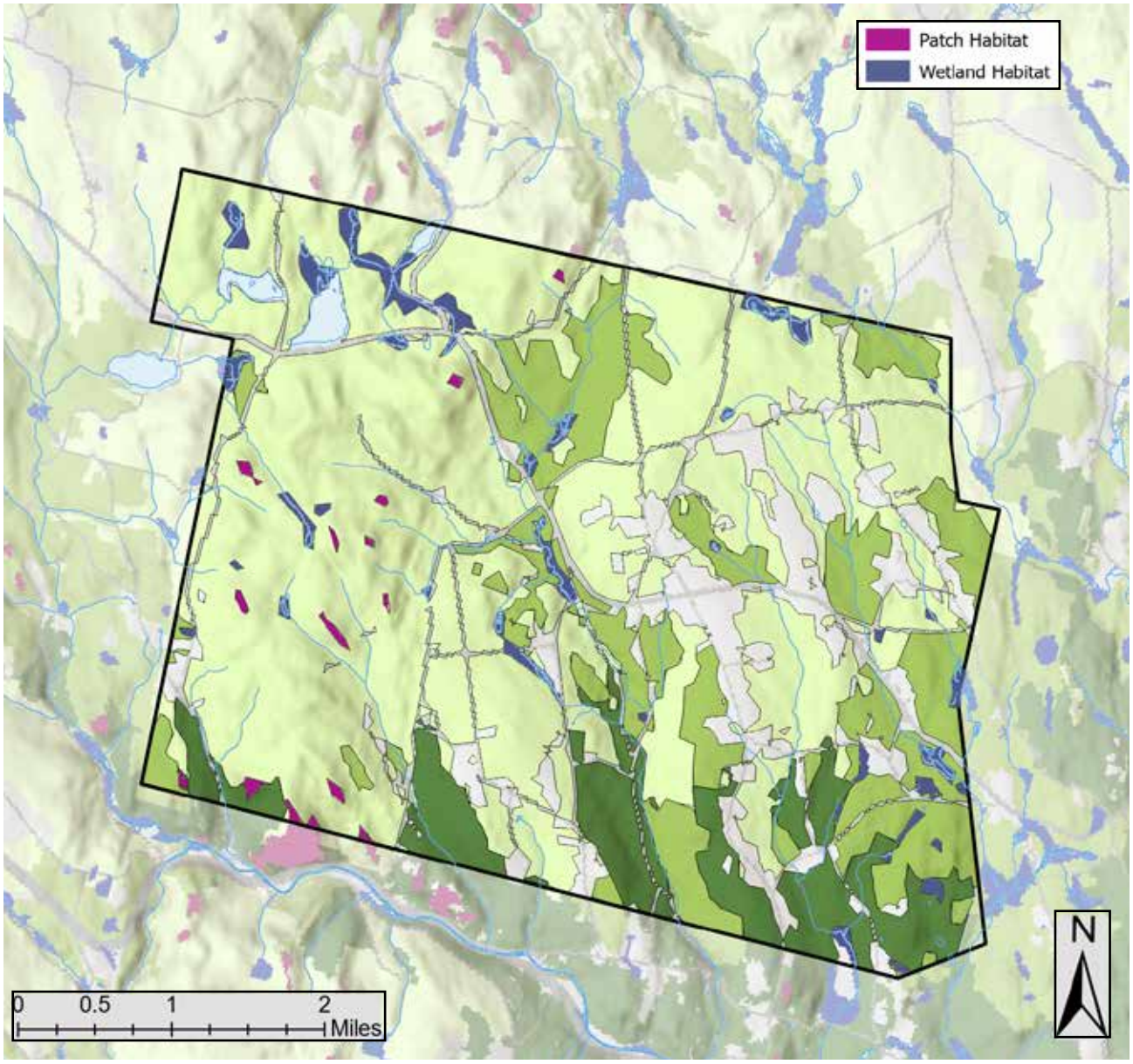


Forest Management in Plainfield

The vast majority of Plainfield's forest is on privately owned land. Woodlot owners are allowed to harvest their lot so long as it aligns with Massachusetts' Forest Cutting Practices Act (FCPA). The FCPA regulates commercial timber cutting of wood products greater than twenty-five thousand board feet (or fifty cords) on any parcel at one time by requiring a forest cutting plan. Plans are subject to a permitting process, and need approval from a DCR forester. There are several exemptions to this process, such as rights-of-way for public utilities and public highways, cultivation or pasture maintenance, non-commercial use by the landowner or tenant, or changing land use (e.g., building, subdivision, mining, etc). The FCPA requires cutting plans to be filed with both the DCR forester and the Town Conservation Commission at least ten business days before the proposed harvest start date. However, the Conservation Commission ultimately does not have jurisdiction over plan approval; this is up to the DCR forester. During community outreach in February 2022, members of Plainfield's Conservation Commission voiced concerns over having minimal jurisdiction over the possibility of irresponsible and/or excessive cutting.

Patch & Wetland Habitats in Plainfield

These habitat types are known for their abilities to host an assortment of species, including more rare or at-risk species per acre than forests, on average. The following section highlights a few of the most diverse, rare, or otherwise important patch and wetland habitats found in Plainfield.



Map 2-3: Distribution of Terrestrial Habitats

Map 2-3 shows the distribution of wetlands and patch habitats in Plainfield. This is overlain on Map 2-2: Matrix Forest Distribution (see page 14). This map does not show each individual type of habitat. This is based on geophysical traits and does not depict exact delineation.

It is recognized that biodiversity does not exist only in these bubbles, and regenerative efforts are important in all natural areas. However, these wetlands and patch habitats are particularly important because of their unique geophysical characteristics, which enable them to host above-average species diversity as well as rare species.

Acidic Rocky Outcrop

Sparsely vegetated habitats found on ridges and summits where bedrock is exposed, or sometimes with a thin soil layer atop acidic bedrock. Trees are sometimes stunted, and at higher elevations include black spruce, red pine, red oak, and scarlet oak with carpets of low heath shrubs or reindeer lichens. At low to mid elevation, typical trees are red oak, white pine, and red spruce with low heath shrubs, including various berries (Anderson et al., 2013). 52.5 acres of this small yet highly diverse habitat type exist throughout Plainfield. These outcrop areas are scattered amongst the West Mountain and Dubuque State Forest tracts in higher elevation areas. Plainfield is at the southern end of this habitat's typical range. This habitat is quite rare in Massachusetts, making up only about 5,000 acres in the whole state.

Acidic Cliff and Talus

Sparsely vegetated cliffs or talus slopes formed on acidic sedimentary bedrock. Vegetation is limited here due to the lack of soil, highly acidic bedrock, and constant erosion. This leaves opportunity for mosses, extensive lichen cover, and some herbaceous cover growing on bare rock and in crevices. Some trees and shrubs are present in deeper soil pockets. This system is adapted to harsh climatic conditions, with frequent disturbance like drought, wind, and storm damage. There is a small three-acre patch of this habitat on a steep, southeast-facing slope of Deer Hill in the southwest part of town.

Central Appalachian Pine-Oak Rocky Woodland

A dry, mixed woodland habitat with trees such as dry-site oaks (scarlet oak, scrub oak, and chestnut oak) and pitch pine. Vegetation can be sparse or patchy; some sites have a rich heath shrub layer. This habitat is accustomed to fire disturbance, and so vegetation will depend on fire history. Given its history with fire, this habitat is one of the more climate resilient types and is well adapted to conditions of drought (USDA, 2015). This habitat is known to host a range of species of concern, such as the peregrine falcon and the timber rattlesnake. There are two small patches of this habitat in the southeast forests of Plainfield.

Laurentian-Acadian Alkaline Conifer-Hardwood Swamp

A forested alkaline swamp with a tree canopy consisting of conifers, such as Northern white cedar. This habitat hosts a rich shrub layer and extensive, diverse moss layer due to its high pH and nutrient content. These swamps are particularly rare in the Northeast, and cover 64 acres in Plainfield. In town, it occurs as isolated patches and also surrounding streams, most notably along the Mill Brook and Swift River corridors. The conifers present in these habitats are important for keeping headwater streams, such as the Mill Brook, shaded and cool.

SECURED LAND IN PLAINFIELD

Words such as "conservation," "protection," and "securement" are often used interchangeably; however, there are often nuanced differences that are important. This section establishes the definitions used in this plan, and is followed by analysis of Plainfield's existing land securement status.

Secured Land Classifications:

U.S. Fish and Wildlife Service GAP System —

Gap 1: Secured for Nature and Natural Processes
Gap 2: Secured for Nature with Management
Gap 3: Multiple use, secured against conversion to development but open for many uses which may include recreation and extraction.
(Crist et al., 1998)

Native Plant Trust & The Nature Conservancy —

Secured refers to land that is permanently secured against conversion to development through public or private fee ownership, easement, or other legal means.
Protected refers to the subset of secured land explicitly dedicated to conserving nature and natural processes (GAP 1) or managed for a primarily natural state (GAP 2)
Multiple Use refers to the subset of secured land that is open to many types of uses including recreation, resource extraction, and management (GAP 3)
Unsecured refers to privately owned land or public land with no conservation restrictions.
(Anderson et al., 2021)

Land Securement: Definitions

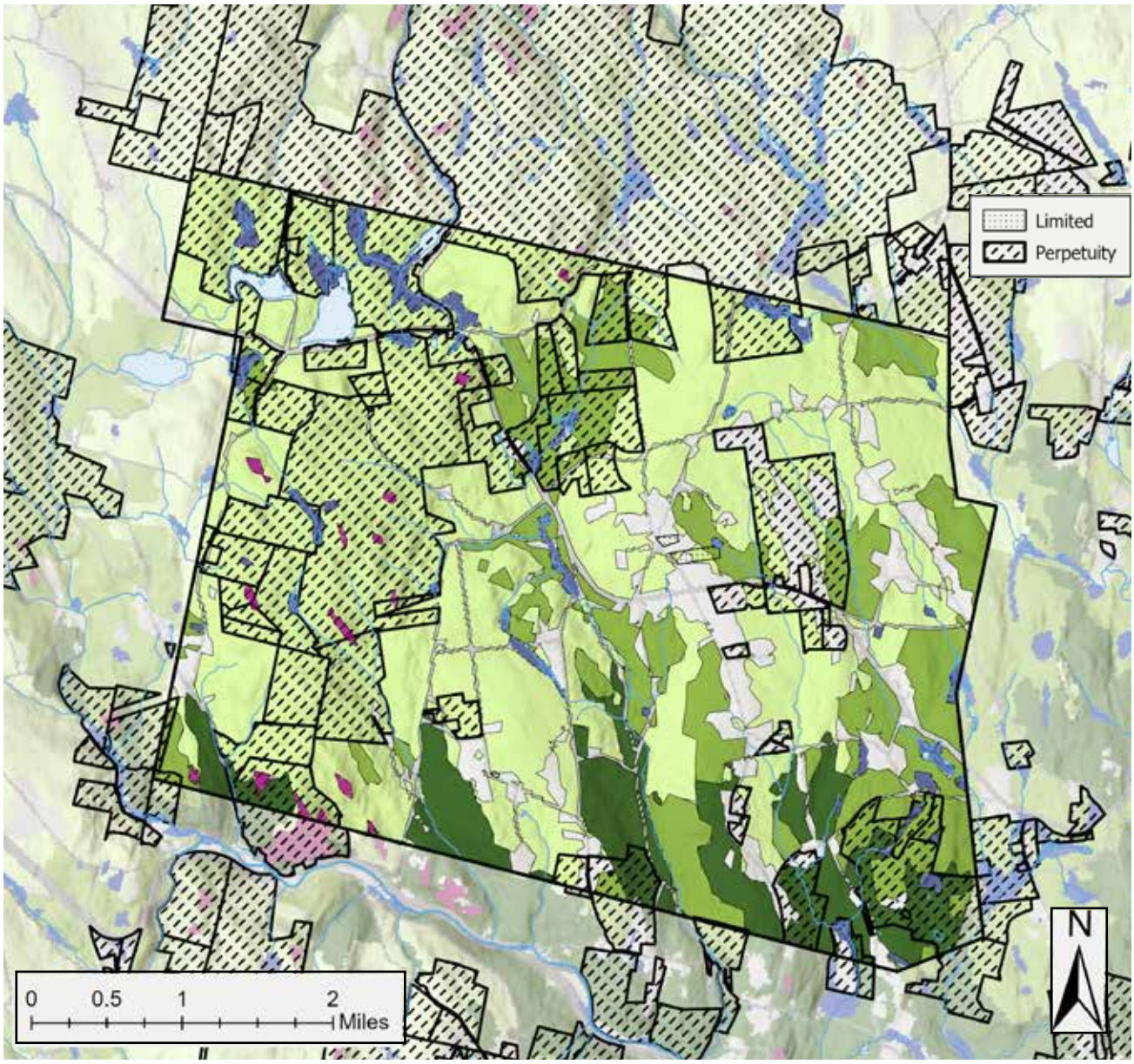
Conservationists argue that maintaining a natural state remains the preferred and most effective tool for conserving species and habitats (Dudley, 2008). Permanently protecting land under a *conservation easement*, also known as a *conservation restriction (CR)*, is a strategy widely employed to ensure land is protected from future development. Secured Land is defined by the U.S. Fish and Wildlife Service as "public and private lands that are permanently secured against conversion to development through fee ownership, easements, or permanent conservation restrictions" (Crist et al., 1998). There are different classifications of **secured land** that are used in conservation analyses (see sidebar). **Unsecured land** is not permanently protected and includes most of the private land in the Northeast.

This classification system does not account for other categories that contribute to species protection such as voluntary agreements and temporary conservation agreements. In Massachusetts, for example, the Chapter 61 program provides landowners with a tax incentive to protect land from development for a certain period of time. Because the protection is not permanent, Chapter 61 parcels would not qualify as "secured land" and are therefore not considered to be permanently protected in this Plan. Nevertheless, Chapter 61 lands can play an important role in conservation (see page 33 for further discussion).

Securing land is most effective when habitat loss, development, and climate change are major threats to ecosystem function. When considering overall biodiversity goals, securing land under a CR is not always appropriate, nor will it work entirely on its own. A combination of tactics is important; see Alternatives & Additions to Conservation Restrictions on page 32.

Land Secured in Perpetuity:

Land permanently secured from development via ***Conservation Restriction*** (CR) or ***Agricultural Preservation Restriction*** (APR).
More than one fourth of Plainfield is permanently secured from development.



Map 2-4: Land Secured in Perpetuity

Map 2-4 illustrates the land secured from development in perpetuity by CR or APR. This map uses Open Space data available from MassGIS. **4,011 acres of Plainfield is secured in perpetuity, or 29.4% percent of total area.** Map 2-4 shows that most of the secured area is in the western part of town, while the central and eastern portions of town are less secured. Map 2-4 does not illustrate temporary securement from development via programs such as Chapter 61.

ECOSYSTEM SERVICES CRITICAL TO CLIMATE RESILIENCE

Forest habitat supports an array of terrestrial species ranging from large canopy trees, understory plants, and large mammals to fungi and soil microbes. These natural systems and species have a long and deep connection to humanity, playing a role in both cultural and community identity. They offer an abundance of services and resources including food, energy, recreation, economic opportunities, and shelter. Services afforded to humans by forests are even more critical when considering climate change; they have great potential to mitigate and help us adapt to climate change (for specific climate projections analysis, see page 22).

Carbon Sequestration & Storage

The latest IPCC report indicates that there is still time and need to mitigate the worst impacts of climate change (IPCC, 2022). Mitigation requires reductions of heat-trapping greenhouse gases (GHGs) like carbon dioxide (CO_2) as well as actions to remove GHGs already present in the atmosphere. Forests are a key part of the mitigation solution, given that trees capture and store CO_2.

How plants capture and store carbon emissions

Plants remove carbon dioxide (CO_2) from the air via photosynthesis and convert it to sugars, which are then converted into energy needed to build and sustain parts of the organism. Given their size and lifespan, trees are especially effective at this process–known as carbon sequestration. Allowing trees in forests to continue to grow and age stores carbon, keeping it out of the atmosphere. When thinking about how forests can help mitigate the worst impacts from climate change, it is important to understand that carbon sequestration is a process, while carbon storage is a state—both are needed and forests provide each of them at different stages in their successional cycles.

Carbon Sequestration—the process of capturing CO_2 from the air and converting it into plant biomass including wood, leaves and roots.
Carbon Storage—Amount of carbon retained long-term in forests.

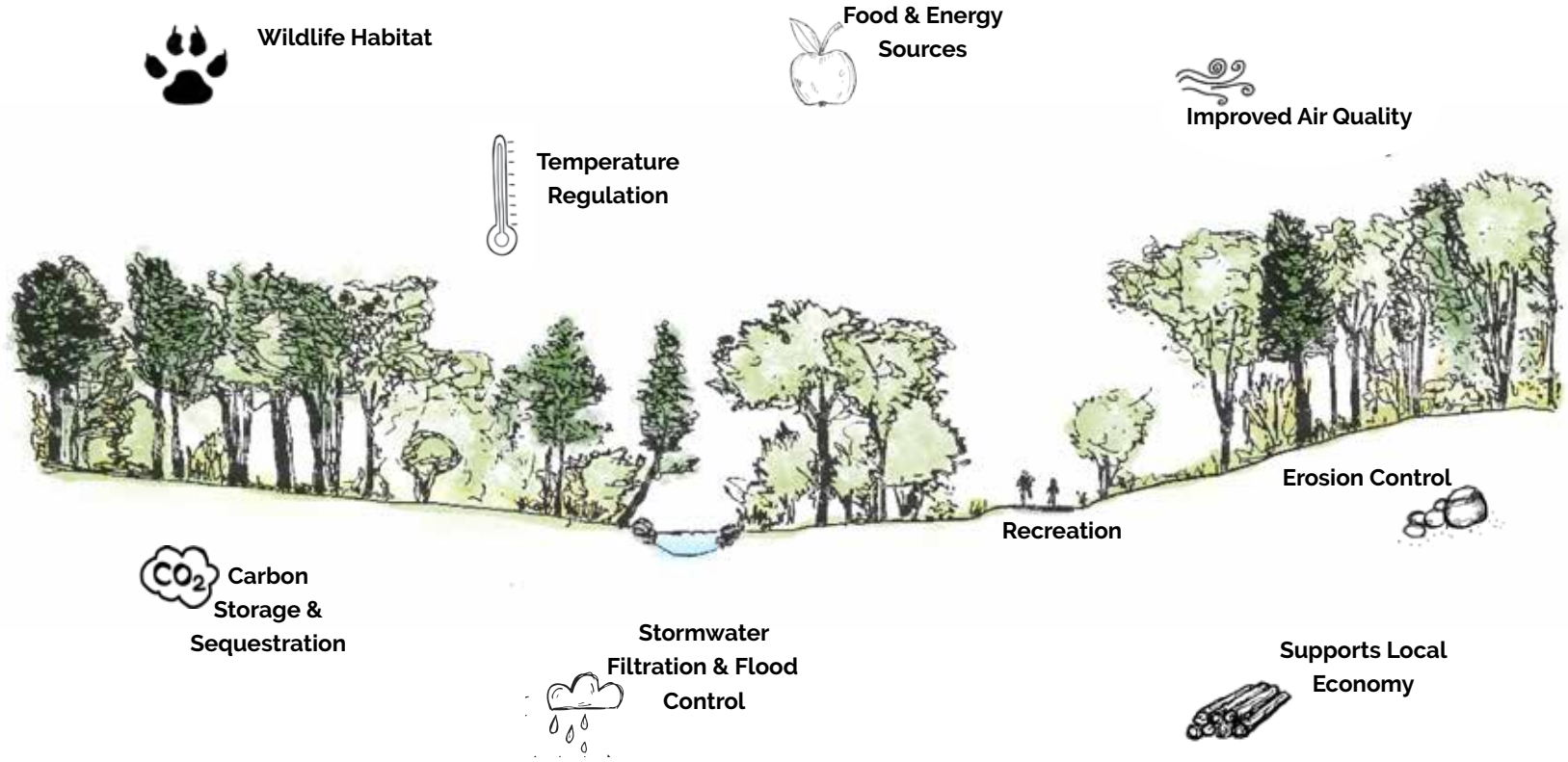
Younger trees sequester carbon at a faster rate, while older forests store more carbon—when trees die, they release carbon over time.

Younger successional forests sequester carbon at a high rate, while old growth forests store the most carbon. Thus, it is important to leave old growth forests intact, while also supporting younger forest growth. As the canopy closes in, sequestration rates decline, but carbon storage increases if the forest remains undisturbed. Because of these differences in mitigation behavior between older and younger forests, forest management choices can greatly influence a forest's ability to provide long-term climate mitigation benefits (see Carbon Markets and Incentives on page 35).

Forest age is not the only factor determining carbon storage capacity. Climate change-related stressors such as pests, pathogens, invasive species, canopy disturbances and increased temperatures can lower sequestration rates and reduce stocks (Quirion et al., 2021). Deforestation for development in New England is a double negative for climate resilience efforts because it adds more carbon to the atmosphere while further limiting capacity to sequester it (NEFF, 2021).

Forest Ecosystem Services

The forests provide a range of services that directly improve quality of life. The costs of replacing such services would be incredibly high, if even possible. Many of these services will be increasingly important as temperatures continue to rise and climate change impacts continue to grow more evident.



Ecosystem Services Critical for Adaptation

While mitigation efforts are critical, it is also important to prepare for adapting to climate change impacts (see page 26). Forests can help communities adapt to climate change by providing shade and reprieve from hotter temperatures, controlling soil erosion from increased storms, filtering water, and improving air quality. Trees and forested landscapes can even help homes conserve energy by providing insulation and windbreaks that reduce heating needs, and shade during summer months which could reduce AC usage.

At the municipal and landowner level, the cost of replacing these ecosystem services with artificial means would be very high. The exact species composition of forested land will change over time, but if the land is stewarded responsibly, the ecosystem function should remain.

CLIMATE CHANGE AND ECOSYSTEM HEALTH

Forests and other ecosystems are best able to continually provide services when they remain healthy and whole. However, impacts from climate change will directly and indirectly shape terrestrial ecosystems over the remainder of this century and beyond.

Ecosystems have endured species die-off throughout history; however, current rates of warming are exceptional, and ecosystems have a variety of stressors testing their resilience. Trees are more vulnerable to threats when they experience major disturbances such as windfall, ice storms, wildfire, and drought–increasing frequency and intensity of these are directly linked to climate change. Other stressors include aggressive species spread (often called "invasive species"), increased pest and disease, and human-caused deforestation and fragmentation. These factors compounded with hardiness zone shifts could change vegetation patterns of ecosystems in Plainfield. Furthermore, fragmentation can lead to entire species decline. What may seem like a minor fragmentation –such as a road or a trail–may be impassable for some species of concern such as wood turtles and spring salamanders.

Certain species are more susceptible to stressors than others. For example, large canopy trees, such as many of the Northern Hardwoods, are prone to windfall. Conifers, on the other hand, are much more likely to spread wildfire. Species diversity helps minimize risk of mass extinction—the more species there are in an ecosystem, the less likely that all of them will die in a stressful event, thus ensuring ecosystems can heal.

The Northeast is already seeing increased instances of pest and disease spread. Most notably at risk is the Eastern Hemlock, which suffers from Hemlock Woolly Adelgid. Emerald ash borer is also a pest that has recently taken to northeastern forests; its spread has caused die-off in ash trees. These certainly are not the only nor are they the last pests to be invading the forests, and much of the future is unknown. However, several general trends can be anticipated.

Species on the southern end of their range generally tend to fare worse with rising temperatures. Thus, species on the northern edge of their range may become important and more abundant such as Northern red oak or tulip poplar. Retaining unfragmented forest allows for species migration and will aid in this transition; however, with expedited rates of warming and continued deforestation, scientists hypothesize that some species may need assisted migration to ensure survival.

Within the overall trend of warming temperatures, localized microclimates created by changes in topography and geophysical characteristics will have unique influences on species composition and may allow species of concern to persist in specific settings. According to the Massachusetts Wildlife Climate Action tool, warmer and drier sites such as south-facing slopes will see a decline in traditional hardwoods (like yellow birch and sugar maple), while drought-tolerant species from the south (such as red oak) are projected to fare well. Conversely, in moist and cool locations, such as northern slopes, traditional hardwoods are projected to survive (CAFE, 2017).

Given these interactions between climate change effects, ecosystem health and function, and compositional shifts, supporting healthy and enduring ecosystem function over the long term will be best achieved through maintaining biodiversity and unfragmented (or contiguous) habitat. Intact corridors are essential for both animals and plants to migrate. Ecosystems are dynamic; species are always moving and adapting to changing conditions, which, over time, alters forest composition. Allowing this movement and species adaptation is important in building overall forest resilience as climate change impacts intensify. Biodiversity is important to protect throughout the landscape, but certain habitat types support species of concern and therefore require special attention.

Tree Species and Climate Vulnerability:

Common species of the Northern Hardwoods Macrogroup are ranked for their likelihood to fair well (+), decline (-), or stay neutral (0) in high or low GHG emissions scenarios (high GHG emissions scenario, low GHG emissions scenario).

American beech (0,-)
Sugar maple (0,-)
Eastern hemlock (0,0)*
White ash (0,0)*
Yellow birch (0,-)
American basswood (0,+)
Red maple (0,0)
Northern red oak (+,+)

(CAFE: "Ecology and Vulnerability: Forest: Beech- Birch- Maple", 2017)

New England Forests and Wildfire: Vulnerabilities and Opportunities

Fire is a naturally occurring component of ecosystem function, and has also long been a tool used by humans. Native people in the Northeast have a long history of using fire to cycle nutrients in the soil for food production as well as to create conditions conducive to wildlife browse and make for successful hunting (Ackerman, 2020). Routine burning regimes can encourage fire-adapted vegetation to remain, while clearing fuels and providing nutrients to soils.

Though a natural phenomenon, centuries of fire suppression brought on by settler colonization have weakened ecosystems' ability to adapt to fire (Parsons and DeBenedetti, 1979). Compounded with the increased droughts that are projected to get worse as temperatures rise, ecosystems are more vulnerable to larger, more destructive wildfires.

There is a debate among experts as to the Northeast's susceptibility to large-scale forest fires. Some sources suggest that the hardwood forests of New England remain relatively safe, lacking the more ignitable conifer canopy found in the West (NEFF, 2021). Yet, other sources say wildfires are on the horizon in the Northeast (Kiefer, 2020). Furthermore, if there is a major takeaway from the fires of the West, large fire events can be unpredictable and spread fast. Given the Northeast is the most densely populated part of the country, it would not take a fire as large as those recently seen out West to destroy many homes.

In Plainfield, the rural nature of the town carries its own risks when it comes to wildfire, namely limited road access for emergency personnel and the presence of above-ground utilities. Plainfield's aging population is also more susceptible to negative health effects from smoke.

These risks and challenges will take a long time, creative solutions, and funding to address. Many communities start with a *Community Wildfire Protection Plan (CWPP)* which oftentimes is incorporated within another plan, such as an updated land use or open space plan. The *Fire Adapted Communities (FAC) Learning Network* offers resources to communities across the country to prepare for a resilient future with wildfire. Members of the network are eligible to apply for Opportunity and Capacity Building Funding via mini grants biannually. Another model is the *FIREWISE USA* framework, which emphasizes the importance of building community resilience and awareness to support ongoing action and education.

Franklin County Hand Crew Pilot Program

Aware of the vulnerabilities to wildfire and declining volunteer firefighter base in Western Massachusetts, fire chiefs from several towns in neighboring Franklin County have joined forces to best prepare, forming the Franklin County Hand Crew. This crew is composed of 75 members, specializing in providing assistance for large, difficult-to-contain forest fires using mostly hand tools (Marcus and Poli 2021). While the crew is made up of members from Franklin County, they extend services beyond county lines; in May of 2021 the crew helped with the Williamstown fire in nearby Berkshire County.

IDENTIFYING CONSERVATION PRIORITIES: METHODOLOGIES

Organizations across the globe have established conservation goals to ensure the health of global biodiversity. In the U.S., the Biden administration has set forth the "Conserving and Restoring America the Beautiful" initiative which calls for locally led campaigns to achieve "30 x 30." That is, 30% of all habitats nationwide should be secured from development by 2030.

New England Target (NET)

In *Preserving Biodiversity in New England*, authors offer a regionally specific roadmap to preserving ecosystem function while working towards climate resilience. The New England Target (NET) is a set of goals for sustaining adequate biodiversity in light of climate change impacts. The NET prescribes securement goals for each habitat type and target percent for each prescribed level. These are summarized in the box below.

New England Target (NET) Habitat Conservation Goals:

Matrix Forests:

30% of forests secured (GAP 1-3)

At least 5% of each matrix forest type protected (GAP 1-2)

Other Habitats

At least 5-15% of all habitats protected (GAP 1-2)

30% of forests secured (GAP 1-3)

At least 75% of securement on climate resilient land

75% of threatened plant species are in ex situ collections (seed banks and living collections at botanic gardens).

The following list indicates regional and statewide under-secured habitats that occur in Plainfield, and their current securement status in town. Each indicated habitat of concern does not currently meet the regional NET goals to sustain regional biodiversity and support ecological climate resilience goals. Note: the following percents refer to regional goals; they are not specific to Plainfield. Some of the following habitat types are fully secured in Plainfield, but are included because ongoing management is important.

Under-Secured Habitats in Plainfield

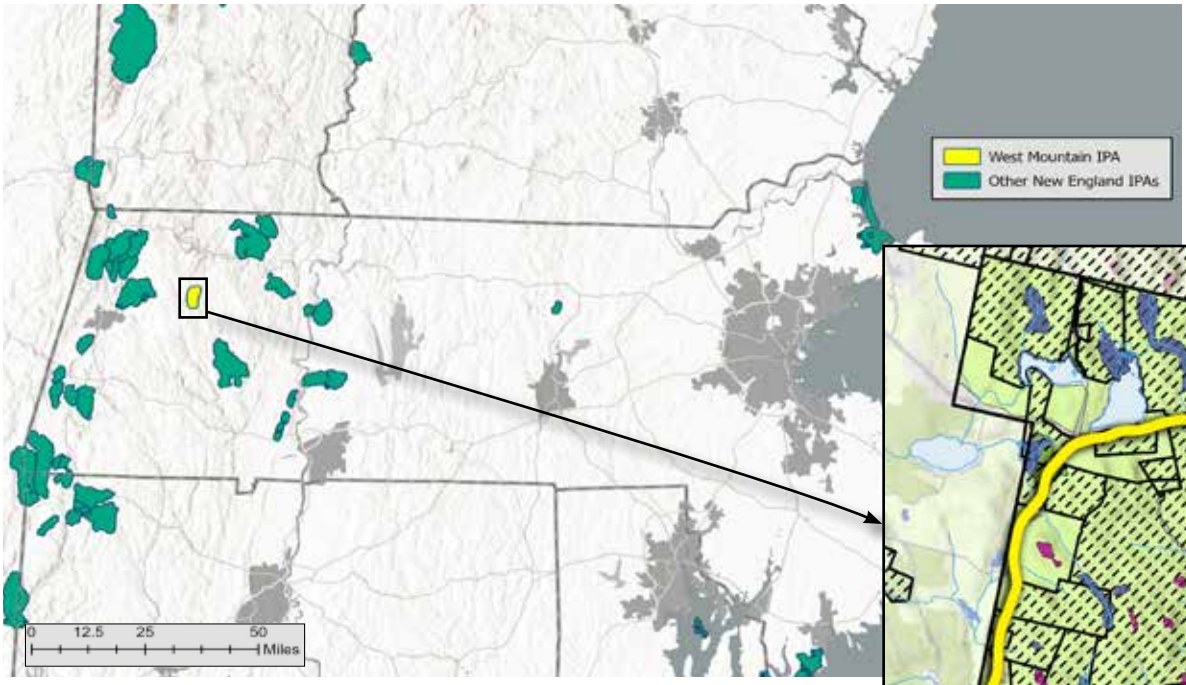
Laurentian-Acadian Pine-Hemlock-Hardwood Forest: This transitional forest type is under-secured regionally, with only 13% of this forest secured and 2% protected. In Plainfield, this forest type is under-secured because it is under-represented in conservation restrictions.

Central Appalachian Pine-Oak Rocky Woodland: Statewide, this habitat is uncommon, accounting for 8,545 acres total. The majority of this habitat is unsecured statewide. Just 463 acres are protected (GAP 1&2) with 2,840 acres in multi-use (GAP 3). Two unsecured patches occur in the southeast section of town, within contiguous forest. This totals just 5.5 acres in Plainfield, but is significant because it is rare and climate resilient.

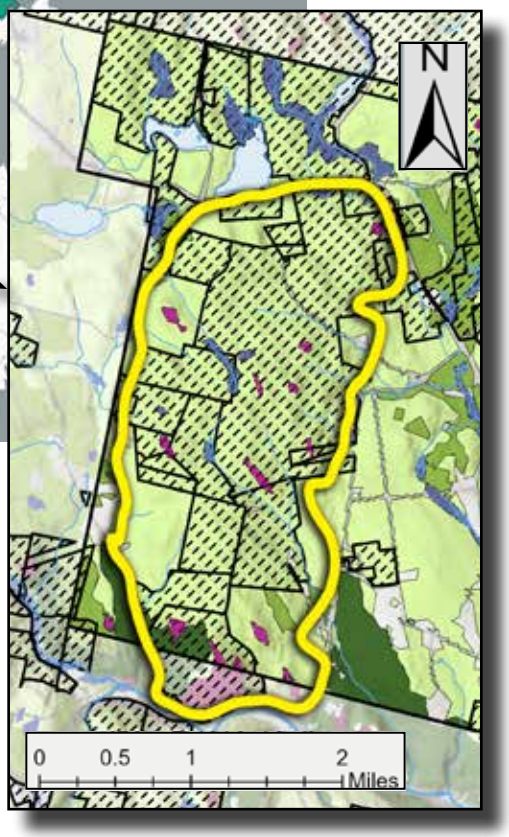
Acidic Rocky Outcrop: Statewide, this rare habitat has 1,107 acres protected (GAP 1&2), while 1,433 acres are currently within multi-use (GAP 3). 2,466 acres remain unsecured in MA. This habitat type is particularly sensitive to human disturbance, and thus might not be ideal for multi-use. Land trusts and CR owners should evaluate management practices accordingly.

Laurentian-Acadian Alkaline Conifer-Hardwood Swamp: This habitat type is currently under-protected in the Northeast, with only 19.5% conserved regionally (Anderson et al., 2021).

Important Plant Areas (IPA)



Map 2-5 (A): Regional Important Plant Areas (IPAs)



Map 2-5 (B): West Mountain IPA

In addition to NET goals, the Native Plant Trust & The Nature Conservancy provide a unique set of goals for 234 designated Important Plant Areas (IPA) in New England. IPAs are large, unfragmented areas designated for their intact nature and above-average biodiversity. The combination of these two factors means they rank high for resilience and are thus top priority for conservation, as determined by these agencies. These agencies argue that securing all 234 IPAs to these goals "would go a long way toward sustaining the region's floristic and habitat diversity" (Anderson et al., 2021). IPA securement goals are to have at least 30% of each IPA protected (Gap 1-2) and at least 75% secured against conversion across habitats and states (Gap 1-3).

One of the identified IPAs includes the West Mountain region in Plainfield, with a small portion extending south into Cummington. This IPA encompasses 2,814 acres of Laurentian Acadian Northern Hardwood forest. This IPA is sandwiched between the Kenneth Dubuque State Forest to the north and the Deer Hill Forest to the south.

The largest property within the IPA is Mass Audubon's West Mountain Wildlife Sanctuary, which has secured 1,812 acres in perpetuity and allows public access. The remainder of parcels under CR within the IPA are held by private property owners, who may or may not allow public access.

In total, 64% of the West Mountain IPA is protected in perpetuity. This does not currently meet the NET goals of 75% securement for all IPAs in New England.

NET Important Plant Area (IPA) Securement Goals:

At least 75% of each IPA secured against conversion (GAP 1-3) across habitats and states with at least 30% further protected from multi-use (GAP 1-2).

Map 2-5 (B) outlines the West Mountain IPA overlain on Map 2-4, see page 23. Map 2-5 (B) indicates that several wetlands and/or patch habitats currently fall outside of protected areas within the IPA.

To access the MAPPR Tool and the data used for this portion of analysis, scan the QR code or visit: https://www.massaudubon.org/our-conservation-work/policy-advocacy/shaping-climate-resilient-communities/our-projects/mappr-project/mappr-tool

Mass Audubon Mapping and Prioritizing Parcels for Resilience (MAPPR) Tool 2.0

Mass Audubon partnered with The Nature Conservancy and LandVest to develop a conservation priority ranking tool, available for free. This tool compiles data from a variety of available GIS layers and ranks parcels based on categories selected. The model assigns color-coded rankings to each relevant parcel from Mass GIS; unranked parcels are not colored, and represent parcels that may already be under permanent conservation or otherwise did not match any of the model criteria.

The following map represents data from running a "balanced" model, which weights evenly the following data layers:

- BioMap2 Core Habitat
- TNC Resilience
- UMass Critical Linkages
- BioMap2 Critical Natural Landscape
- Adjacency to protected land
- Parcel size
- Underrepresented settings.

Figure 2-1 shows the parameters selected to generate the data to make Map 2-6. Scan the QR code to access the MAPPR tool.

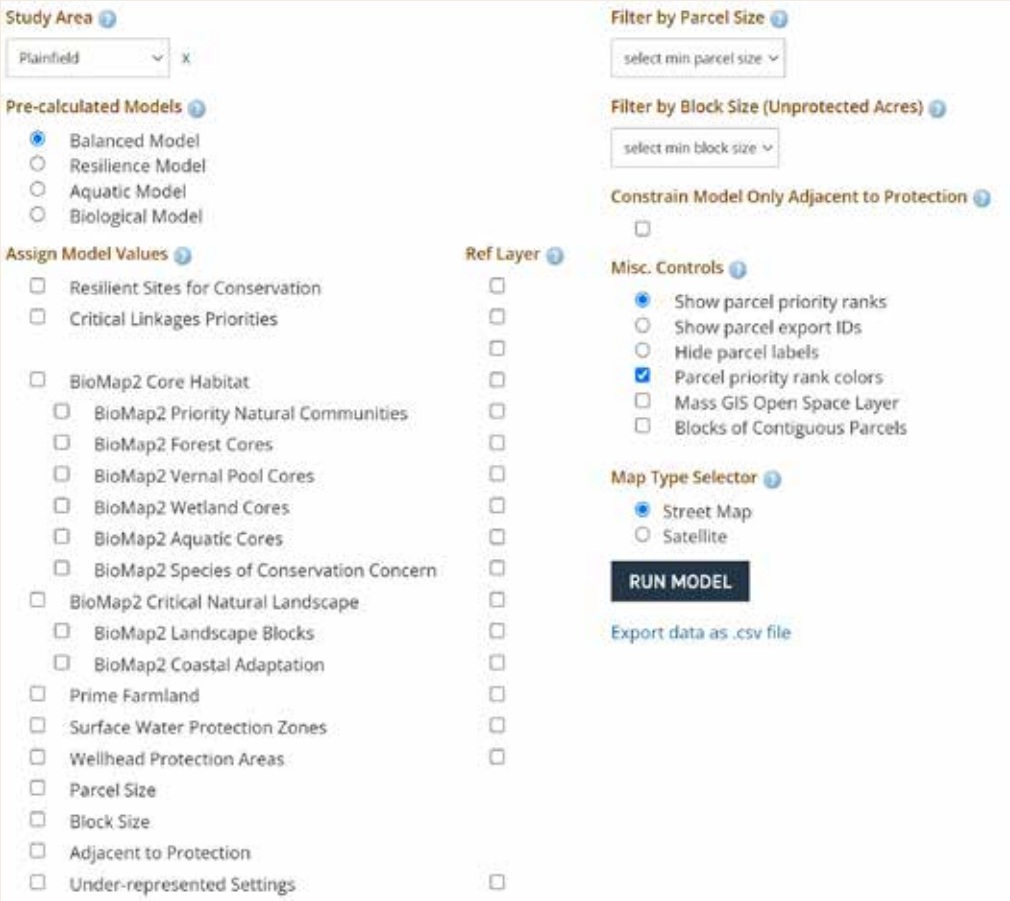
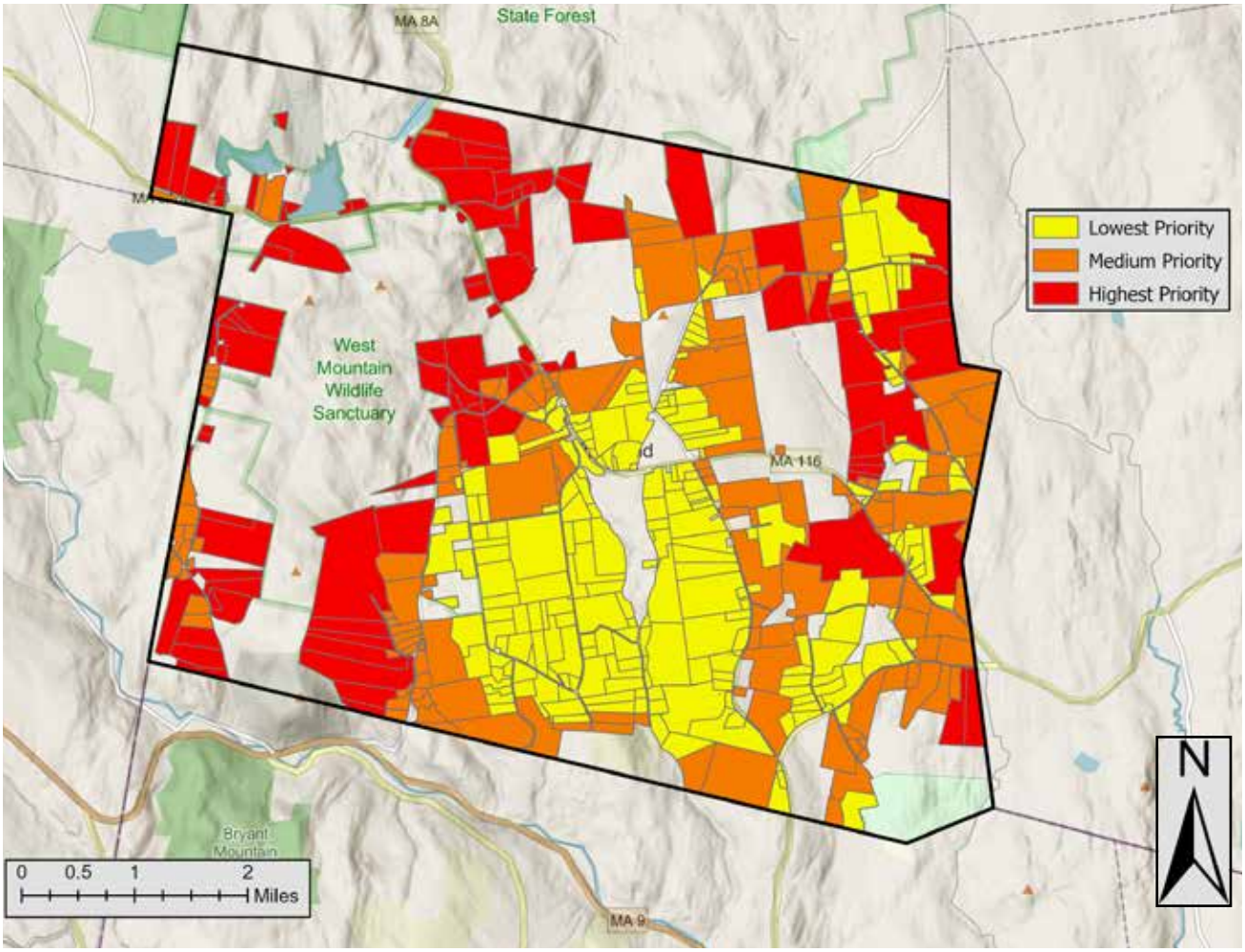


Figure 2-1

Note: When using the MAPPR tool on the Mass Audubon website, results will be generated using 2016 data. For more recent data, download theWcsv file. Map 2-7 was made with ArcGIS Pro, using data from the downloaded table.



Map 2-6: MAPPR Priority Rankings

Using the Balanced Model, the tool illustrates darkest red parcels as the highest priority for protection, orange is mid-priority, while yellow is lower priority. Ranking parameters can be adjusted based on selected inputs, which might be helpful to adjust when grants have certain parameters (see Figure 2-1).

Results

When weighting the categories evenly using the balanced model, the resulting map affirms many of the conclusions of the ecosystem analysis in this chapter. A concentration of high priority parcels fall within the contiguous forest that covers West Mountain; several of these are within the Native Plant Trust's Important Plant Area (IPA). Furthermore, it is likely that several parcels ranked as high priority contain areas of the important patch habitats and/or wetlands previously discussed in this chapter.

Wood turtles have been spotted in Plainfield's woodlands. They are a species of concern (NatureServe).

CONSERVATION TOOLS

Many different types of tools have been developed to help local governments and other entities conserve land. The following section describes some of these tools.

Conservation Restrictions

Conservation Restrictions (CRs), in Massachusetts, are legally enforceable agreements with the purpose of permanently securing land for specific conservation values. These are also known as conservation easements. They require approval by the Secretary of Energy and Environmental Affairs, and are to be deemed in the public interest. This is a commonly employed tool to secure sensitive and important habitats, among its many other uses.

While permanently protecting land for conservation can be an effective way to support biodiversity, it can be problematic. Putting land under a CR is often a costly and lengthy process, with real equity concerns, among other issues (Burnett et al., 2021). Furthermore, when land is enrolled in a CR, it reduces the Town's property tax revenue. Roughly one third of Plainfield is owned by land trusts that have placed CRs on their properties. Compounded with a highly limited commercial tax base, diminished revenue means that it is unlikely the municipality has capacity on its own to acquire parcels for protection if available. This section reviews alternatives to Conservation Restrictions as methods to retaining biodiversity and supporting ecosystem resilience.

PAYMENT IN LIEU OF TAX (PILOT) PROGRAM

Oftentimes, CR land is owned or managed by property tax exempt entities such as government agencies or non-profits. PILOT is a repayment program to reimburse municipalities for lost revenue for property tax exempt public spaces, such as open recreation areas and solar arrays. In theory, the program makes direct payments to municipalities or provides other means to achieve lost income. However, underfunding has led the program to fail rural communities who rely on this income. Problems with the PILOT program have garnered attention in recent years (Parnass and Jin, 2021). Bill S.1875 aims to reboot the program in ways that may benefit rural, Western Massachusetts communities (Mass.gov, 2022).

Cultural Easements & Use Agreements

Cultural easements aim to protect and secure cultural assets of a landscape. Cultural Use Agreements are agreements between landowners and cultural or tribal groups to allow for land use and/or comanagement of land. They are growing in popularity, and can offer an alternative avenue to securing important cultural and spiritual assets as well as ecologically significant areas. When rooted in justice, this could be used as a tool to diversify the types of cultural sites granted historic protection status and ensure these sites' preservation.

Examples of use agreements include:

- *Saint Regis Mohawk Tribe was granted black ash harvesting permits and management in NY.* This cultural keystone species is under threat of decline from climate change impacts; granting the tribe priority rights and management of black ash allows for careful and culturally informed management of the species (NIACS, 2017).
- *Dennis Land Trust and Native Land Conservancy Cultural Respect Agreement in Cape Cod, MA* was the first cultural respect agreement east of the Mississippi, granting tribal access and use to ancestral lands (Vaughn, 2016).
- *Co-management and Wabenaki plant harvesting (sweet grass) in Acadia National Park, ME* (First Light, 2021). First Light Learning Journey has an online toolkit to inspire projects to expand Wabenaki uses of land, and can be accessed through this page: https://firstlightlearningjourney.net/resources/cultural-easements-and-culture-use-agreements/

It is important to understand that each of the above examples were indigenous-led; each tribe has unique initiatives, desires, and methodologies.

Historic Forest Sites

In addition to rich vegetation, New England's Forests are rich with history. There are hundreds of historic stone structures throughout these forests, including within Plainfield. While there is some speculation over the original intent of some of these long lived structures, there is evidence that many of them predate European colonization (Gage and Gage, 2008). Just like ecosystems, historic and cultural structures are vulnerable to climate change and development pressures. Earning protection status may help these historic structures to live on.

Ex Situ Conservation

When a species is threatened and unlikely to survive even in habitats that are protected at the highest levels, that species may be a good candidate for ex situ conservation. This practice allows species to continue to exist in botanical gardens and collections, and be made available for reintroduction in appropriate settings. Reintroduction could be a tool to achieve more biodiversity if and when climate-induced species extirpation progresses to dangerous levels. Regional organizations, such as the Native Plant Trust and the New England Wildflower Society, are actively working to collect local specimens.

Tax Exemption Programs: Chapter 61 (A, B)

When other protections are not possible or feasible, there are incentive programs for landowners that aim to protect land from development, if even provisionally. It is important to note that these programs do not ensure the survival and/or protection of habitat, but rather they protect land from development (often temporarily).

The state of Massachusetts provides tax exemptions to undeveloped lands through the 61 program. The aim of this program is to incentivize landowners *not* to develop their lands; there are three categories of Chapter 61 land use:

Chapter 61—Forestry

Chapter 61 A—Agriculture

Chapter 61 B—Open Space and Recreation

Lands enrolled in Chapter 61 require management under an approved ten-year forest cutting plan, thereby placing the property under temporary protection from development for that ten-year duration. Landowners may prepare their own plans, although the Massachusetts DCR recommends that a licensed forester be hired to prepare the plan instead. Regardless, the plan must be reviewed and approved by a state service forester. However, there are no minimum management requirements specified by the state, as long as some active management is being conducted. Therefore, the type, timing, and extent of management impacts are decided by the landowner and their private forester. These forest management plans do not necessarily ensure climate resilience or carbon mitigation.

Sustainable Management Options

Careful management of forests can sustain ecosystem function, provide revenue, and aid in GHG reduction goals simultaneously. In community outreach meetings, stakeholders voiced concern over the climate impacts of deforestation and irresponsible timber management. They expressed interest in alternatives that are more specifically focused on carbon mitigation. However, there are many challenges to overcome. Often, forest owners turn to timber harvest to sustain livelihoods or to generate income, and there may be no financial incentive to develop an alternative plan. The Town lacks authority to dictate forest management plans; the Conservation Commission expressed concern over their lack of jurisdiction over state cutting plans, as they consider state requirements to be too lenient in some cases. Additionally, landowners may desire a carbon-focused plan option, but not know where to begin or whether a suitable program is available to them.

Currently, there are several resources available for landowners and municipalities to employ more

sustainable management practices. Mass Audubon's *Climate-Smart Forestry* initiative aims to provide a framework for climate resilient forest management that "helps forests adapt to changing climate conditions [and] removes carbon dioxide from the air & stores it in the forest to mitigate climate change." Their webpage is a good starting point for landowners and municipalities to explore options and resources.

Keeping Forests as Forest

One way to retain forest ecosystems is to encourage sustainable forest management. There are increasingly more sustainable forestry options available to landowners; these programs allow landowners to keep their forests forested, when they may not have been able to afford to, traditionally.

Sustainable Forestry Funding

Cost-share programs supplement the costs of implementing climate-smart forest management plans, and a few of these programs offer incentives or aim to add additional incentives as programs expand. The Mass Woodlands Institute and DCR have partnered on the *Forest Stewardship Program,* which provides a cost-share for a forester to prepare a forest management plan for landowners and municipalities. Currently there are two options: a standard stewardship plan, and Foresters for the Birds which is specifically aimed at promoting bird habitat.

Some cost-share programs are aimed at municipalities, such as **Community Forest programs.** This model allows communities more input in establishing management goals and outcomes, which could ultimately empower people to build connections with neighbors and ecosystems. These programs do require active communities and/or co-management partners.

Community Forest Stewardship Grants from the State may be a funding opportunity for the Town to acquire forested land, if it became available. This program does require a match. Previous grant recipients obtained the Buffam Brook Community Forest in Pelham, MA. The Pelham Conservation Commission partnered with Kestrel Land Trust to acquire 161 acres of land as a "living laboratory… used to demonstrate sustainable forestry practices that will help forests adapt to climate change and recover from large scale natural disturbances."

That specific project obtained additional funding through *the Community Preservation Act Fund* (CPA).

Carbon Markets and Incentives

Stakeholders expressed particular interest in programs that provide direct payments for carbon mitigation services provided by their forests. One funding option that is growing increasingly popular among municipalities, large businesses, and even individual landowners are carbon markets. **Carbon markets** operate on the concept that carbon stored in one place, such as forests, can offset carbon emissions from another source. These markets place a financial value on the carbon storage that forests provide, allowing landowners to receive compensation equivalent to that value in exchange for preserving the carbon storage capacity. Essentially, the landowner sells a credit, which can be purchased by another entity such as a corporation that can discount the carbon represented by that credit from their own emissions. Therefore, these markets do not directly reduce reliance on fossil fuels, and detractors claim that allowing entities to "pay to pollute" continues to uphold exploitative systems. However, proponents argue these programs may improve protection and quality of forests by incentivising more landowners to retain forests rather than harvest them, thus contributing to overall climate net zero targets.

Carbon markets can be either regulatory (where entities are required to purchase carbon credits to meet an emissions cap) or voluntary. Carbon registries track credit ownership to make sure there is no double-counting. Forest carbon projects can be complex and intimidating to understand and navigate. Typically, a landowner would work with a carbon project developer who would manage the project on their behalf in exchange for either a fee or a share of the credits generated by the project.

Participation in a carbon market requires a long term commitment on the part of the landowner to maintain their forest, since they technically no longer "own" the carbon stored within it. There are also costs and constraints such as minimum parcel sizes. Many early carbon markets were focused on very large-scale projects requiring thousands of acres, effectively shutting out small private landowners. Recently, however, an increasing number of options have become available for municipalities and private landowners to participate, either with smaller minimum lot sizes or the option to aggregate multiple projects for greater impact.

Other programs such as the *Family Forest Carbon* model pay landowners for practices that are expected to increase carbon storage over time, rather than direct participation in a carbon market model. This program is currently operating a pilot phase in Massachusetts targeted at private landowners, though it is anticipated that municipal lands will be eligible in the future. These types of "payment-for-practice" programs may be a good option for smaller towns that need funding for forest management but do not have the capacity to meet the administrative requirements of direct carbon market participation (Rapp and Lautzenheiser, 2020).

Proforestation advocates argue that maintaining existing forest has the highest net carbon storage potential (Moomaw et al., 2019). To date, there does not appear to be any incentive programs for proforestation, though advocacy groups such as RESTORE and Save Mass Forests are hoping to change that.

Webpage Resources for Landowners Interested in Carbon Sequestration Forestry:

- ***Securing Northeast Forest Carbon***–https://www.northeastforestcarbon.org/
- ***Family Forest Carbon Program (FFCP)***–https://www.franklinlandtrust.org/family-forest-carbon-program/
- ***Mass Audubon's Climate Smart Forestry***–https://www.massaudubon.org/our-conservation-work/ecological-management/habitat-management/climate-smart-forestry

RECOMMENDATIONS FOR TERRESTRIAL HABITAT RESILIENCE

Make land justice a top priority

As stated at the beginning of this document, climate resilience is best supported through a diversity of tactics and this involves the inclusion of a diversity of people, cultures, and perspectives (ESF, 2022; IPCC, 2022). All of the recommendations in this Plan should center around equity and be pursued with a critical eye towards land justice.

Involve local native people, including tribes who have been forcibly removed, and other communities most oppressed by settler colonization, from the beginning of all discussions involving ecosystem conservation.

This plan has not been reviewed nor endorsed by any tribal nation or group, and thus it is essential that the Town connects with tribes and organizations at the earliest stages of implementing this plan.

The following approaches are examples that have been employed to work towards restorative futures for people and land; these approaches should not be employed before communication with and express approval of Black, Indigenous, People of Color (BIPOC) collaborators and/or communities. It is of utmost importance that non-native allies and BIPOC collaborators are clear and aligned in the outcome they want before any of these approaches are adopted and pursued.

Mohican Nation (Stockbridge-Munsee band of Mohican)

Their ancestral lands include what is now called Plainfield. They have an office in New York.

https://www.mohican.com/

Nipmuc Nation

Has ancestral ties to these lands and have an active presence in this region, their contact information is on their web page.

www.nipmucnation.org/

Ohketeau Center

Located nearby in Ashfield, MA. They do a lot of cultural education and workshops.

https://www.ohketeau.org/

Karuna Center for Peace

Based in Greenfield, MA. This organization works to educate the public, and provides educational materials and workshops on topics including land justice.

https://karunacenter.org/

Examples of Land Justice approaches:

- **Uplift and continue with education about indigenous cultures of the region**. As an institution that was founded by settler colonial violence, it is important that the Town acknowledges the role it may play in upholding systems of oppression and works towards building trust and mutual respect with groups most harmed by colonial violence in order to heal and build stronger collective resilience. Building respect and understanding is an essential step to restorative justice. Education can bridge gaps in understanding and boost cross-cultural respect. There are many groups and individuals both locally and regionally working to educate the general public on histories and cultures often left out of mainstream narratives.

  Connecting with local and regional tribes and cultural centers (listed above) can help to support ongoing educational efforts about indigenous culture, in history and in the present. Town platforms, such as the website, Town hall meetings, etc. can be used to amplify BIPOC stories and initiatives.

- **Educate residents on rematriation and co-management of land (See Appendix).** There are an increasing number of instances where private landowners, land trusts, and municipalities have returned land to tribal nations and made reparations with BIPOC people. See inset for local examples of this type of land justice.
- **Add information and resources about reparations and voluntary land taxes to the Town's website.** Voluntary land taxes are one way to support reparations efforts. Some attendees of a recent event held by Plainfield Reads indicated that they choose to pay reparations via voluntary land taxes. Adding more information about reparations efforts to the Town web page could raise awareness of this as an option. Resource Generation has a toolkit on their web page that could be a good place to start: *https://resourcegeneration.org/land-reparations-indigenous-solidarity-action-guide/*

Local examples of rematriation and co-management:

- ***Rematriation of Lampson Brook Farm,*** Belchertown, MA: Unceded Nipmuc land is being returned for the first time in history, significantly increasing the tribe's access to their ancestral lands (Berg, 2022).
- ***Kibilio Refuge Community & Farm,*** Leyden, MA: Black and Queer Land Sovereignty group recently acquired 95 acres for a yoga retreat sanctuary *https://kibilio.org/*
- ***Wabenaki Co-management in Acadia National Park***, Acadia National Park, ME: Wabenaki co-management and plant harvesting of sweet grass *https://firstlightlearningjourney.net*

- **Pursue cultural easements, and/or cultural respect agreements.** Cultural easements and cultural respect agreements, such as those described on page 28, are tools that can support the protection of ecological and cultural sites. These may also be a method to protect cultural keystone species.

Protect Biodiversity and Important Habitat

The following recommendations should be used in conjunction with the NET habitat protection goals. However, the Town should also continue with efforts to support biodiversity in all habitats; for example, through native plant demonstration gardens that educate residents, such as the pollinator garden at the post office.

New England Target (NET) Habitat Protection Goals:

Matrix Forests:
30% of forests secured (GAP 1-3)
At least 5% of each matrix forest type protected (GAP 1-2)
Other Habitats
At least 5-15% of all habitats protected (GAP 1-2)
30% of forests secured (GAP 1-3)
At least 75% of securement on climate resilient land
75% of threatened plant species are in ex situ collections (seed banks and living collections at botanic gardens).

Prioritize protection of patch habitat parcels within the Important Plant Area (IPA) for conservation.

Patch habitats located within the IPA rank the highest priority for securement according to the MAPPR tool (see page 27). Securing these parcels would fulfill a large portion of the NET goals for this IPA. These parcels also rank high for resilience because they are abutting permanently conserved lands on West Mountain. Prioritizing securement of these identified parcels would support ecosystem health by preserving contiguous forests and securing patch habitats that have higher than average biodiversity.

The typical approach to permanent land protection would be through Conservation Restrictions. However, these can be problematic. Putting land under a CR is often a costly and lengthy process. Furthermore, when land is enrolled in a CR, it is taken off the tax roll for municipalities. Roughly one third of Plainfield is owned by land trusts in CR—one of the reasons why the Town receives little tax revenue. Compounded with a highly limited commercial tax base, it is unlikely the municipality has the capacity on its own to acquire many additional parcels for protection. Therefore, focusing efforts on a top priority areas will have the highest impact. There may also be other alternatives to CR for land protection, such as cultural easements, that could be appropriate in Plainfield.

Consider bylaws and/or zoning tools to protect important habitat and species outside the IPA.

These tools can be used as an alternative to CR acquisition where there is a need for protection yet CR is unfeasible or undesired. Species and habitats could be protected through establishing species-specific tree protection bylaws for climate-threatened species where they are projected to fare well. **Tree protection bylaws** could also protect old-growth trees that store the most carbon. For example, such bylaws could involve: not cutting sugar maples on north slopes or in wetlands, permit-only harvesting of climate resilient species to support their establishment and migration northwards, and protecting trees of larger calipers to ensure old growth trees continue to store carbon. Other bylaws and zoning tools such as implementing buffer zones on important habitats, or zoning overlay districts to protect certain forest types, could also be explored as options. The following two areas are recommended places to start:

Tree protection bylaws are primarily directed at providing protection for native trees, trees with historical significance, or trees over a certain trunk diameter. They usually require that a permit be obtained before protected trees can be removed, encroached upon, or in some cases, pruned. Some tree protection ordinances may disallow their removal.
(Urban and Community Forest Program, 2021)

- Implement bylaws that afford buffer zones to patch habitat: Patch habitats have a density of rare species "ten times higher than wetlands and forty times higher than upland forests," yet they are not afforded the same protections as resource areas regulated by the Wetlands Protection Act (Anderson et al., 2021). They are often sensitive to foot traffic and other anthropogenic disturbances.
- Consider establishing no-cut zones or tree protection bylaws in important coniferous wetlands. This approach may be more rapidly implementable than securement, and could ensure sensitive habitat has protection sooner. This would also add further protections to wetlands outside of the IPA. Retaining tree cover in coniferous wetlands will help to ensure that headwaters remain colder for longer, and it could allow for certain tree species at risk of decline—due to drought or temperature rise—to persist longer because of the higher moisture and cooler temperatures.

Conduct a natural and cultural resources inventory that provides a portfolio of the significant natural, cultural,and historic resource areas of Plainfield's forests.

Cultural sites and natural resources are abundant in Plainfield's forests; this land has been stewarded for thousands of years. Climate change will make forests vulnerable to particular challenges such as increased weather disturbance (see page 22), and the impacts of climate change on the forests will affect cultural and historical sites. Guidance from tribal communities and the Historical Commission should be used to formulate specific policies and/or strategies for the protection and management of such areas and natural resources. These should include consideration of climate change's effects on historic sites, structures, and cultural keystone species. The risk of impacts from natural disturbance to these areas should be reduced if possible (e.g., revegetate if needed or if major plant loss is predicted). There are efforts underway in Plainfield to protect historic stone structures; Town leadership should connect with groups leading these efforts to understand how to best support them (Tribal Adaptation Menu Team: Section 7.1).

Update the Open Space and Recreation Plan (OSRP).

Open Space and Recreation Plans (OSRPs) guide conservation planning and management of open spaces within a municipality. Open spaces include natural areas, conservation land, agricultural land, parks and recreation sites, roadway corridors, and any other open area that is owned by an agency or conservation organization (CAFE, 2017). State guidance indicates that plans should be updated every seven years. Plainfield's OSRP was last updated in 2003. Revisiting and re-envisioning the OSRP would allow the Town to clarify its values around conservation and open space, open up funding opportunities, and incorporate climate resiliency into the plan. The town could conduct a Community Wildfire Protection Plan (CWPP) as a part of the OSRP, (see page 23.)

Citizen Science: Opportunities for Residents to Contribute to Biodiversity Efforts

Citizen science is the involvement of volunteers in science, and plays a critical role in informing ongoing studies (Chandler et al.). These studies allow communities and organizations to develop effective approaches to supporting biodiversity.

- ***Citizenscience.gov:*** Online catalog that lists citizen science initiatives and projects across scales, globally.
- ***Seek by iNaturalist***: General species ID app that gathers data by location.
- ***Invasive Plant Atlas of New England (IPANE)***: Invasive species tracking with a smartphone app and online at *www.eddmaps.org/ipane/*
- ***Go Botany by the Native Plant Trust***: Online native Plant ID and catalog. Their PlantShare Community offers an online database to upload plant sightings, at *https://gobotany.nativeplanttrust.org/plantshare/*

Manage Forests for Climate Resilience

Keeping forested lands as forests allows trees to capture and store carbon to reduce atmospheric greenhouse gasses (GHGs). Climate resilient forestry practices may offer an avenue for land owners to retain their forest while also allowing for a sustainable yield.

Continue and expand efforts to educate landowners about sustainable forestry practices and incentive programs.

As discussed on pages 30-31, there are increasingly more opportunities for landowners to participate in sustainable forestry practices. Carbon incentive programs are also expanding rapidly and more are expected to be available to owners of smaller parcels this spring (2022) in Western Massachusetts. The Town should inform residents as these programs become available, and monitor programs to determine if any would be applicable at the Town scale. To date, there does not appear to be any incentive programs for proforestation, though advocacy groups such as RESTORE and Save Mass Forests are hoping to change that.

There are still unknowns about forests' exact role in overall GHG reduction, and more research is required. Plainfield may present a unique opportunity for research initiatives, having a predominantly forested landscape with high carbon storage/sequestration potential. These forests are an incredible asset not only for the town but for the rest of the region.

A good place to start would be to consult with Mass Audubon's Climate Resilience team given their specific insight into the rapidly growing carbon incentive programs for landowners. Mass Audubon is available to consult with Town officials and residents on climate resilience options. Decisions for landowners may be complex, and Mass Audubon can aid with providing up-to-date information and guidance. A staff member or a volunteer board member should be designated to head up these discussions. Contact: climateforestry@massaudubon.org

Work with land trusts and state agencies to understand management priorities and discuss preferred management strategies for critical locations (i.e., sensitive habitats, transitional forest).

Almost a third of Plainfield's land area is owned or managed by land trusts or state agencies, yet the general public does not know a great deal about what happens on all of these properties. During public engagement activities conducted for this Plan, stakeholders vocalized concerns about a recent clear cutting on the Guyette Farm Property owned by the Franklin Land Trust. They also expressed a sense of disconnection from Mass Audubon, which owns the West Mountain Wildlife Sanctuary. Some stakeholders were concerned about accessibility, a lack of clarity on signage within that area, and a curiosity about the space. In both scenarios, there appears to be a lack of communication between the land trusts and residents. Land trusts are in a unique position, with opportunities to provide services and information while also benefiting from local resources and knowledge. More community engagement could promote mutual resilience efforts. There may be opportunity to improve the dialogue between the Land Trusts, the Town, and the general public, perhaps by sharing forest management plans or objectives. Land Trusts also have the opportunity to garner more public support by acting as a role model for sustainable forest management; encouraging transparency around forest management plans can also improve public perception of these organizations, and lead to cooperative long-term solutions.

Consider Community Forest opportunities.

The U.S. Forest Service's Community Forest and Open Space Conservation Program (CFP) is aimed at towns with forest assets, to help keep forests intact while serving the community's goals. The US Forest Service offers grants to municipalities seeking to purchase land for community forest projects.

Plainfield currently owns only a small amount of land in town, and likely does not have funds if more land were to become available. Programs such as the CFP could be an avenue for the Town to protect forest land and could afford stakeholders input into forest management plans. The ability of the Town to take advantage of this program depends on if and when ideal parcels become available. Given that funding is tight, crowd-sourcing is an option to supplement funds. With Plainfield's active and connected community, this may be a viable funding strategy.

Chapter 3

Water Resources

SECTION SUMMARY

The future availability of clean water is a critical component of climate resilience in Plainfield. Water is abundant on Plainfield's landscape, moving through an interconnected series of wetlands, ponds, and streams. Residents value the recreational opportunities afforded by many of the bodies of water including swimming, fishing, paddling, and strolling along streams and wetlands. The community benefits from wetlands and vegetated land along streams that slow, filter, and absorb stormwater, reducing the impacts of floods and preserving water quality. Water serves as the underlying foundation of many critical habitats for aquatic and terrestrial species alike.

Surface waters also influence the quality of groundwater, which serves as Plainfield's drinking water supply. Residents in Plainfield tap groundwater through individual private wells. Groundwater is replenished by rainfall that percolates through rock and soil, and additionally by streams and ponds where surface water meets groundwater. While surface waters are not directly accessed for drinking in Plainfield, their health directly influences the quality of the underground drinking supply that Plainfield residents rely on (Cohen, 2014).

Various climate change impacts threaten to disrupt access to clean and abundant water resources in Plainfield. Predicted increases in the severity and frequency of storms—and the seasonal shift in their occurrence—are likely to cause significant impacts from flooding, resulting in increased risk of erosion, sedimentation, and contamination. Hotter temperatures and longer periods of dry weather between rain events may also deplete the quantity of water both on the surface and underground. In addition, these climate vulnerabilities could be compounded by future development and land use decisions that impact the quantity and quality of available water.

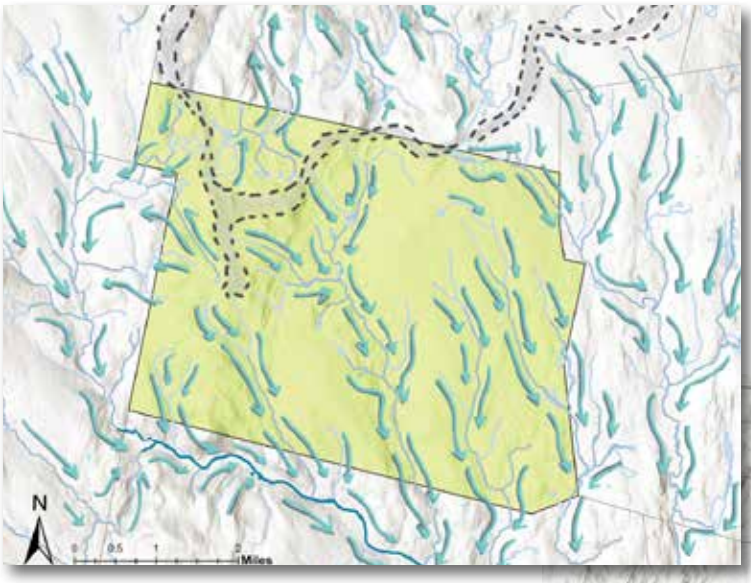
To protect water resources in Plainfield, it is imperative to maintain riparian forests, guide new development and infrastructure upgrades to be water-sensitive, and further study current non-point sources of pollution and how they may be impacting surface and subsurface water quality. These recommendations will contribute to Plainfield's climate resilience as well as that of communities downstream. It is therefore also recommended that the town advocate with downstream communities and partners for obtaining payment for these ecosystem services through the state's payment in lieu of taxes (PILOT) program.

This chapter will describe in further detail the characteristics of Plainfield's waters, how the landscape and human decisions can detract from or contribute to water quality and availability, and why this matters in the face of a changing climate. After a discussion of these observations and implications, a list of recommendations outlines strategies for ensuring the resiliency of Plainfield's waters for generations to come.

A Town at the Top of Two Watersheds

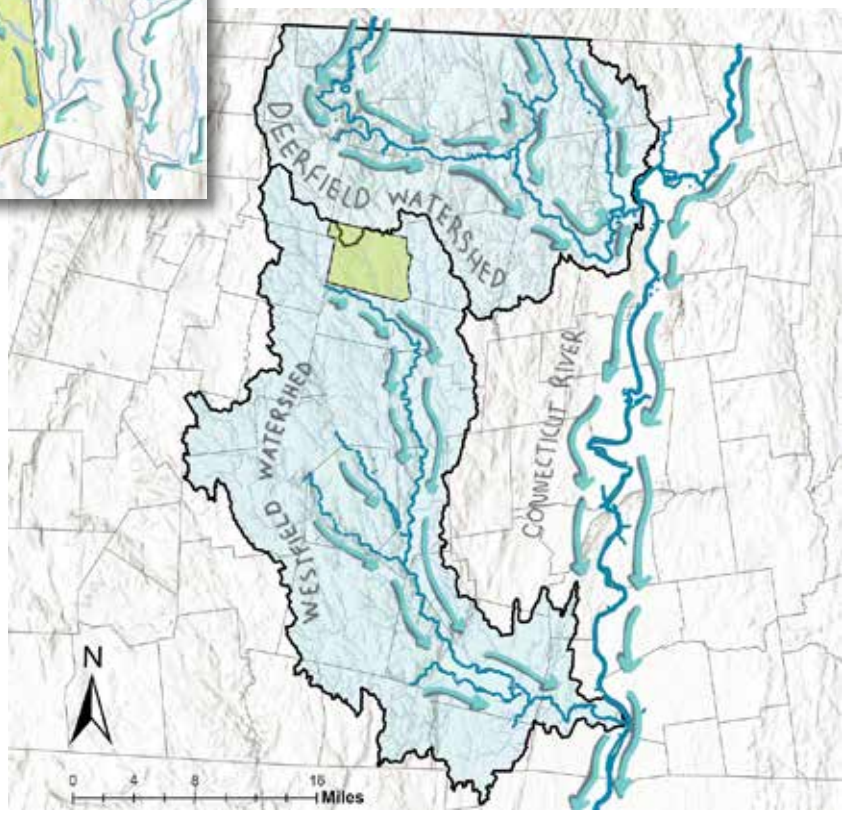
The movement and characteristics of water bodies in Plainfield are influenced by the form of the landscape. In Plainfield, a tall ridge spans the northern portion of the town, represented by the dotted line on the map below. This ridge, which includes the highest point in Hampshire County, forms the boundary between two watersheds. Most of the water in Plainfield flows south and west off the ridge, forming into streams that eventually drain into the Westfield River. A smaller portion drains north into the Deerfield River. Both of these rivers eventually flow into the Connecticut River, which runs south to the Long Island Sound.

Plainfield's location at the top of this watershed system means that water flows from within the town's boundaries out to its neighbors. Therefore, actions in Plainfield directly influence the quality of waterways in downstream communities. The Massachusetts Integrated List of Waters designates all of Plainfield's streams as Category 2, meaning they are unimpaired for some uses and not assessed for others. However, the Westfield River in Cummington, just south of Plainfield, is listed as Category 5, meaning it is impaired for one or more uses and requires a restorative action plan to limit pollutants. This designation indicates that the Westfield River does not support primary contact recreation, such as swimming, due to the presence of bacteria that often indicate the presence of fecal matter in water. The Deerfield River is also listed as Category 5 once it reaches the town of Shelburne. The Connecticut River is also listed as Category 5 (MA Integrated List of Waters, 2021).



Local Drainage

A ridge spanning the northern portion of Plainfield is represented by the dotted line on the map. Water flows down off this ridge to neighboring towns. This ridge forms the boundary between the Deerfield and Westfield River Watersheds.



Watershed Context

Water from Plainfield flows south into the Westfield River and north into the Deerfield River. Both rivers eventually drain into the Connecticut River to the east.

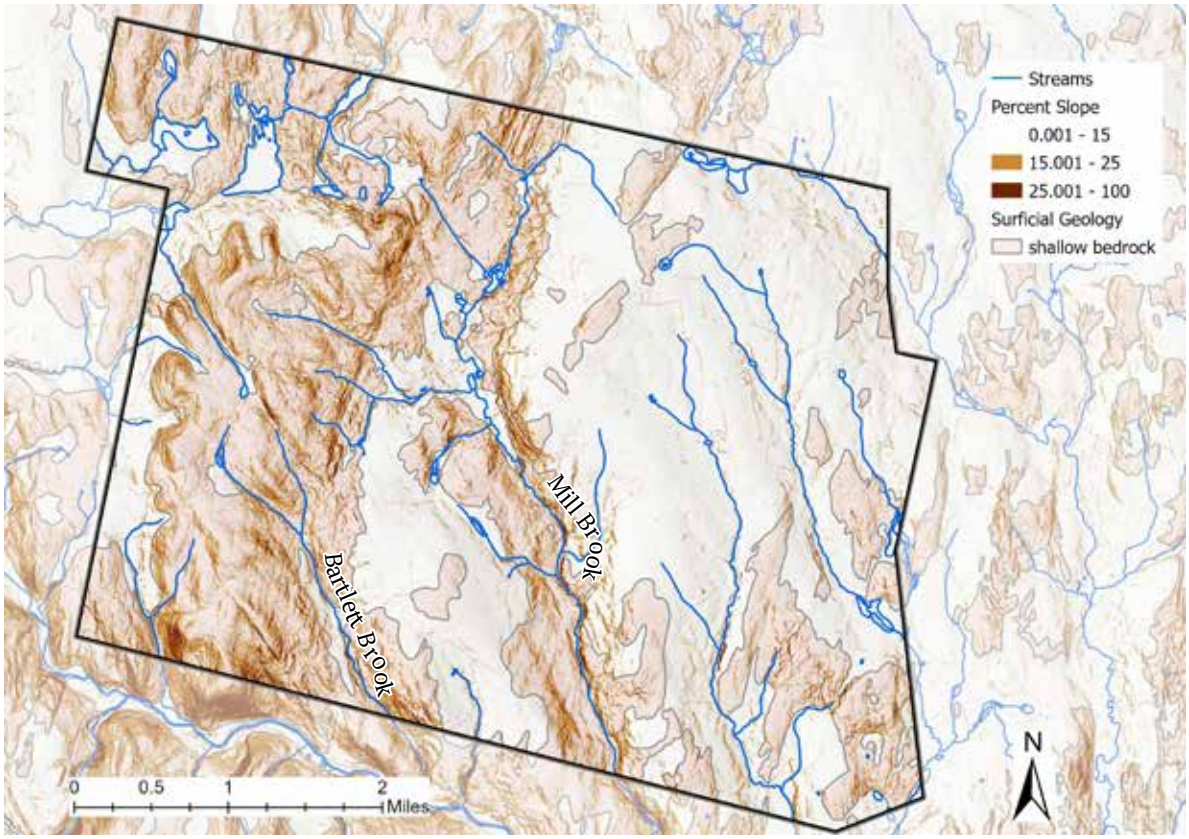
While Plainfield's headwater streams might be cleaner than these larger rivers, they still may carry pollutants that contribute to the impairment of downstream rivers. It is important for those living in Plainfield to consider how the stewardship of their water resources influences not only their own resilience, but the resilience of the region as a whole. Plainfield's unique position at the boundary of the two watersheds could be conducive to the town serving as a key collaborator between different watershed groups.

Slopes and Surficial Geology

Being at the top of the watershed means that streams in Plainfield are generally small. Many streams are sourced from groundwater seeps, providing cool, clean water that is critical for many types of species like brook trout, salamanders, and aquatic invertebrates (New Hampshire Fish and Game, 2013). However, the characteristics of these small streams differ as they flow downhill, in part depending on the physical characteristics of the land near them and over which they flow.

Streams that flow down steep terrain where bedrock is at or near the surface will generally flow much faster. Shallow bedrock and steep slopes create faster stormwater runoff rates, contributing to a greater amount of water that enters streams during rain storms. This results in higher peak flows—the maximum rate of water moving through a stream over the duration of a storm. Times of peak flow are when adjacent lands are most vulnerable to damage from flooding.

Therefore, streams with steep terrain and shallow bedrock have a natural tendency to experience frequent and abrupt flooding that causes erosion and contamination. Map 3-1 shows areas in Plainfield where there is shallow bedrock and/or steeply sloping terrain. Generally speaking, slopes between 15% and 25% are susceptible to some erosion and slopes greater than 25% are particularly vulnerable. Areas in Plainfield with such conditions include the western portion of town, which partially drains to Bartlett Brook and Windsor Pond Brook, and the area underlying and along Mill Brook.



Map 3-1. Shallow Bedrock and Steep Slopes

Areas of Plainfield with shallow bedrock are shown in light grey. Slopes between 15% and 25% are shown in orange and slopes greater than 25% are shown in dark red.

Impervious Surfaces

Impervious surfaces such as roads, houses, and driveways can also contribute to higher, more damaging stream flow. These surfaces block rainfall from permeating down into the soil, instead shedding it as stormwater and creating more potential for high peak flows. In addition, runoff from impervious surfaces will often carry harmful pollutants like road salts, heavy metals, oil and grease from cars, and sediment. Runoff from impervious surfaces is usually warmer than streams, which is harmful for many aquatic organisms that depend on cold water temperatures. Being such a rural community, Plainfield has very little impervious surface; only approximately 1.8% of land is covered by impervious surfaces (see Map 3-2).

Despite being relatively small, the impervious footprint in Plainfield still presents a concern for water quality, flood resiliency, and aquatic habitat. A land cover analysis, later discussed on pg. 48, determined that 90 parcels in Plainfield have a built structure within 200 feet of a perennial stream or within 100 feet of intermittent streams and wetlands. These structures often have lawn, paved or gravel areas, or farmland around them that may also contribute to polluted stormwater runoff. In addition, some of these structures are vulnerable to flood damage because of their proximity to streams.

Roads and Stream Crossings

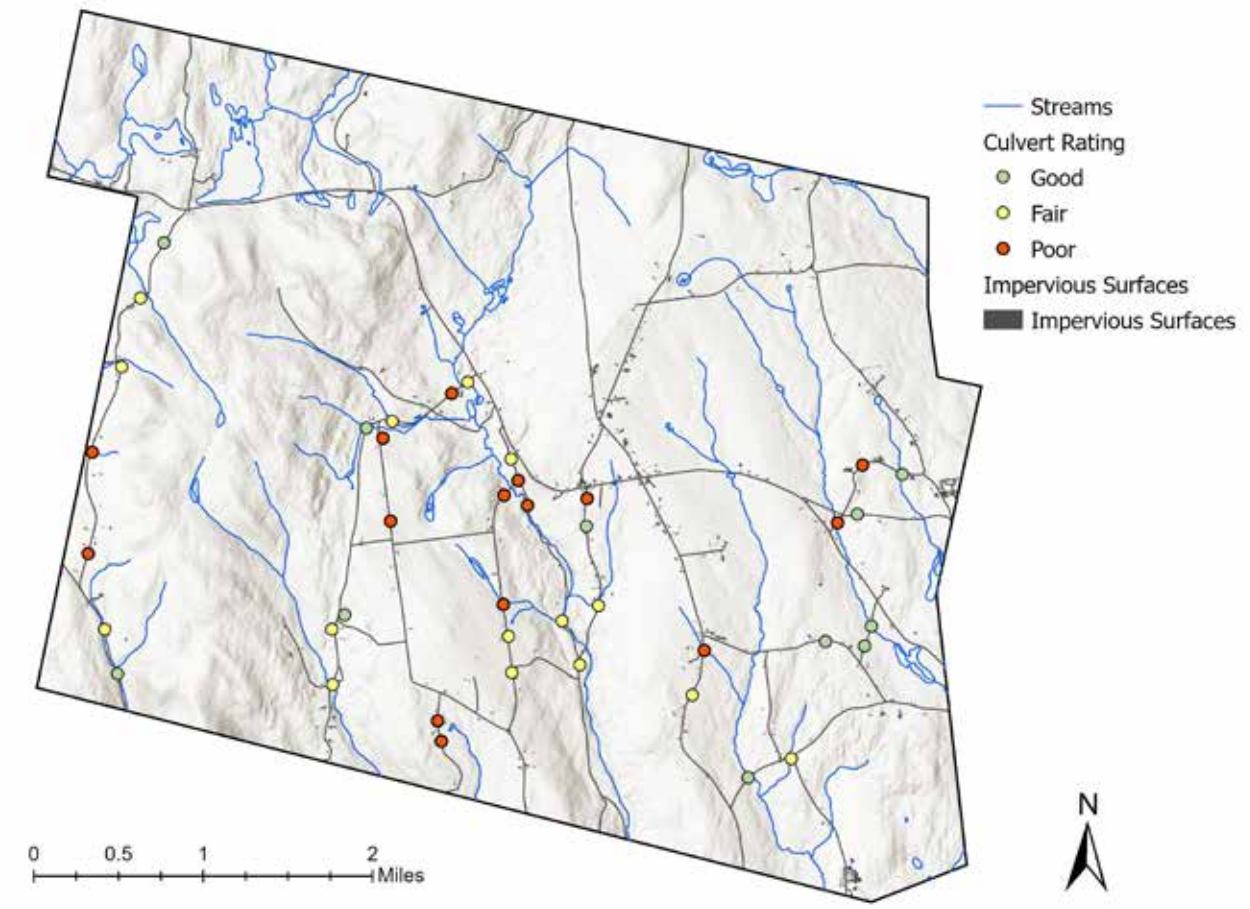
While current residential developments present some threat to water quality, Plainfield roads have an especially fraught relationship with water. Roads tend to lie close to waterways, often crossing streams and bisecting wetlands. This presents a problem for water quality, aquatic habitat, and the longevity of the roads themselves.

According to the 2019 Municipal Vulnerability Preparedness summary report, 20 of the town's 52 miles of road are unpaved. These dirt roads, especially those on steep terrain, commonly experience washouts and erosion from spring snowmelt and larger storms, occasionally making them impassable. This was identified as a vulnerability in the MVP, as it limits residents' access to emergency services. The consistent need for road maintenance also taxes the Town Highway Department, which operates with a limited number of staff and funding.

One of the contributing factors to road washouts are undersized and degraded culverts. In 2020 Plainfield contracted the engineering firm Vanasse Hangen Brustlin to complete a visual assessment of 41 existing culverts to determine their condition. Of the 41 assessed, the evaluation found 15 culverts in poor condition. These culverts were nearing complete structural failure, were fully or partially blocked by vegetation or sediment, had stream flows by-passing the culvert, or were experiencing significant undercutting or erosion.

Above: A dirt road after a late winter thaw. Many of these dirt roads are susceptible to erosion and washouts.

Right: A culvert in Plainfield where water has eroded and undercut the culvert, making it impossible for most wildlife to travel through the culvert.



Map 3-2. Impervious Surfaces and Culverts

Impervious surfaces are shown in dark grey. Culverts assessed in the 2020 engineering report are shown as circles with green in good condition, yellow in fair condition, and red in poor condition.

During large precipitation events, degraded or undersized culverts present a serious flood hazard. Streams can become backed up behind culverts and other crossings that are too small or blocked by debris to allow the water to flow through. The backed-up water often flows over adjacent roads and properties. The pressure of the water can also undercut banks and potentially cause the culvert and the road above to collapse, making it impassable. In addition, these culverts act as barriers to fish and other aquatic organisms that depend on stream continuity to access various forms of habitat (Massachusetts Stream Crossing Handbook, 2018).

Mill Brook

Mill Brook flows through the center of Plainfield and serves as a popular fishing spot. As shown in Map 3-1 on the previous page, the land around Mill Brook is steep with shallow bedrock: conditions that contribute to high water velocity in the stream. Several mills were built along Mill Brook during the 1800s to take advantage of the power of its fast-moving water. It is likely that these old mills and their associated dams still impact the river today. Often, streams were straightened at mill sites, which causes even faster water movement. During large storms, this can make the surrounding land even more prone to flooding and erosion. It is unknown to what degree historical development affects Mill Brook, but during a community meeting in February 2022, residents expressed concern about future development along Mill Brook.

Agriculture

Agriculture's influence on water quality depends in part on the practices employed by the individual farmer. Farms that rely on the application of fertilizers, pesticides, and extensive tilling of soil are more likely to cause erosion and contamination of nearby waterways and groundwater. However, not all farms are the same. Reducing reliance on chemicals and tilling and increasing the use of perennial crops and buffer strips can greatly reduce the impacts of agriculture on water quality and flooding risk. Plainfield's Right-To-Farm bylaw encourages many of these responsible farming and agricultural activities. Farming in Plainfield predominantly occurs on the eastern half of town within the sub-basin of Meadow Brook and the North Branch of the Swift River. Any impacts to water from farming are most likely to occur in these areas (see Map 4-3 showing Plainfield's farm land on pg. 60).

Wetlands

A wetland is an area that is commonly inundated or saturated with water and has vegetation typical of wet soils. Wetlands are dotted across Plainfield's landscape and can take different forms. Types of wetlands in Plainfield include open marshes dominated by herbaceous plants, wooded swamps with dense tree canopies, shrub swamps, and bogs and fens which feature spongy peat deposits. All of these types of wetlands serve important roles in the watershed. They are particularly adept at controlling flooding by absorbing and holding rainfall and runoff. They will often filter out contaminants from water runoff and provide habitat for a wide range of species.

Water and Biodiversity

Plainfield's waters are important for many forms of wildlife and unique plant communities. The Natural Heritage and Endangered Species Program (NHESP) of Massachusetts surveys and maps rare species and plant communities with significant biodiversity in their Biomap2 project. As part of this study, it identifies core habitats, which are "specific areas necessary to promote the long-term persistence of rare species, other Species of Conservation Concern, exemplary natural communities, and intact ecosystems" (2012). Most of the identified core habitat areas in Plainfield are associated with streams, wetlands and vernal pools. These can be seen in Map 3-3.

Biomap2 identifies important aquatic core habitats for fish and other aquatic organisms all along the North Branch of the Swift River, as well as along a tributary of Mill Brook that extends into the West Mountain area. These streams and connected wetlands provide particularly intact corridors that

Photo Credit: Massachusetts Division of Fisheries and Wildlife

Vernal Pools

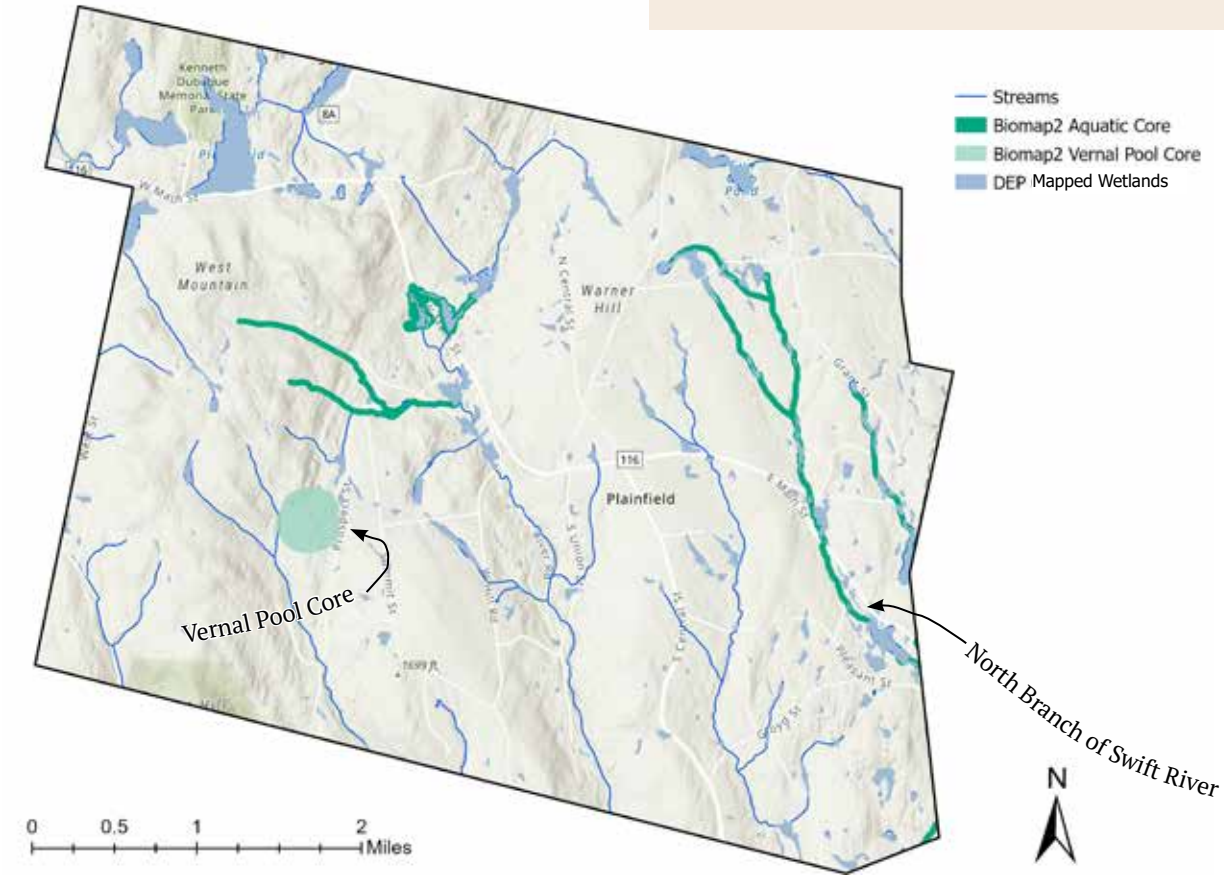
Vernal pools are small, seasonally flooded depressions that serve as important breeding habitat for many amphibian and invertebrate species such as the marbled salamander seen to the left. There are many vernal pools in Plainfield, including a cluster near Bartlett Brook that is identified as a Vernal Pool Core by the Natural Heritage and Endangered Species Program.

allow species like brook trout and wood turtles to migrate freely to access food, shelter, and spawning grounds at different times of year. In addition, Biomap2 identifies a vernal pool core just east of Bartlett Brook which provides breeding habitat for amphibians such as the spring salamander. According to Biomap2, the species of conservation concern associated with Plainfield's waterways include the ski tipped emerald dragonfly, the wood turtle, spring salamander, and Michaux's sedge (Biomap2 Plainfield, 2012). How these individual species might contribute directly to climate resilience is not well understood. However, an accepted principle is that maintaining high biodiversity is critical to the overall health of ecosystems such as wetlands, streams, and forests. The greater biodiversity in these natural communities, the greater chance they have at surviving and adapting to disturbance events and changing conditions, such as those associated with climate change.

Photo Credit: Elena Zachary

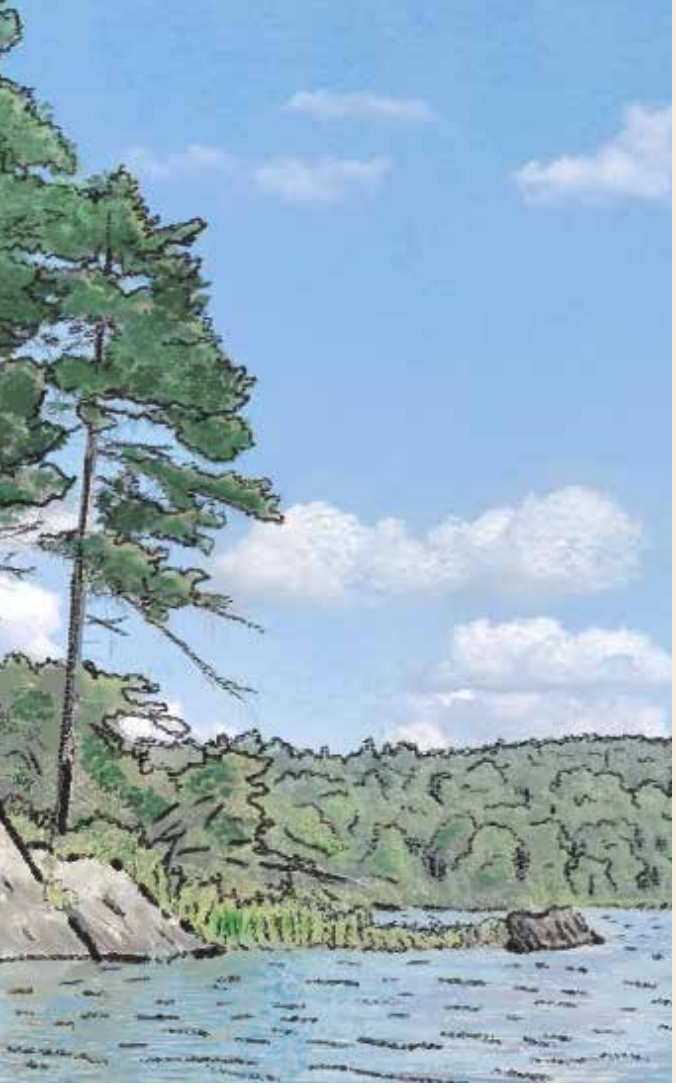
North Branch of Swift River

The North Branch of the Swift River flows north to south on the east side of town. This small stream is noted by the Natural Heritage and Endangered Species Program as core habitat for maintaining biodiversity. The corridor of the stream is largely uninterrupted, allowing species to travel up and down its course.



Map 3-3. Biomap2 Aquatic Core and Vernal Pool Cores

Biomap2 Aquatic Core is shown in dark green along the North Branch of the Swift River, a series of wetlands off Route 116, and a tributary of Mill Brook flowing down from West Mountain. A Biomap2 Vernal Pool Core colored as light turquoise is located north of Bartlett Brook in the southwest corner of town.



Plainfield Pond

There are a series of three ponds located in the northwest corner of town. Plainfield Pond is the largest of the three, covering approximately 57 acres, and is one of the most recognized features of Plainfield's landscape. The beach on the south shoreline off Route 116 is a very popular swimming spot. Many people from the surrounding area also come to paddle, fish, and hike along its shores. Much of the western and northern shorelines are protected as state forests and are heavily wooded. In a stakeholder meeting in February 2022, several Plainfield residents commented on the value of the pond to the community and the importance of preserving its health.

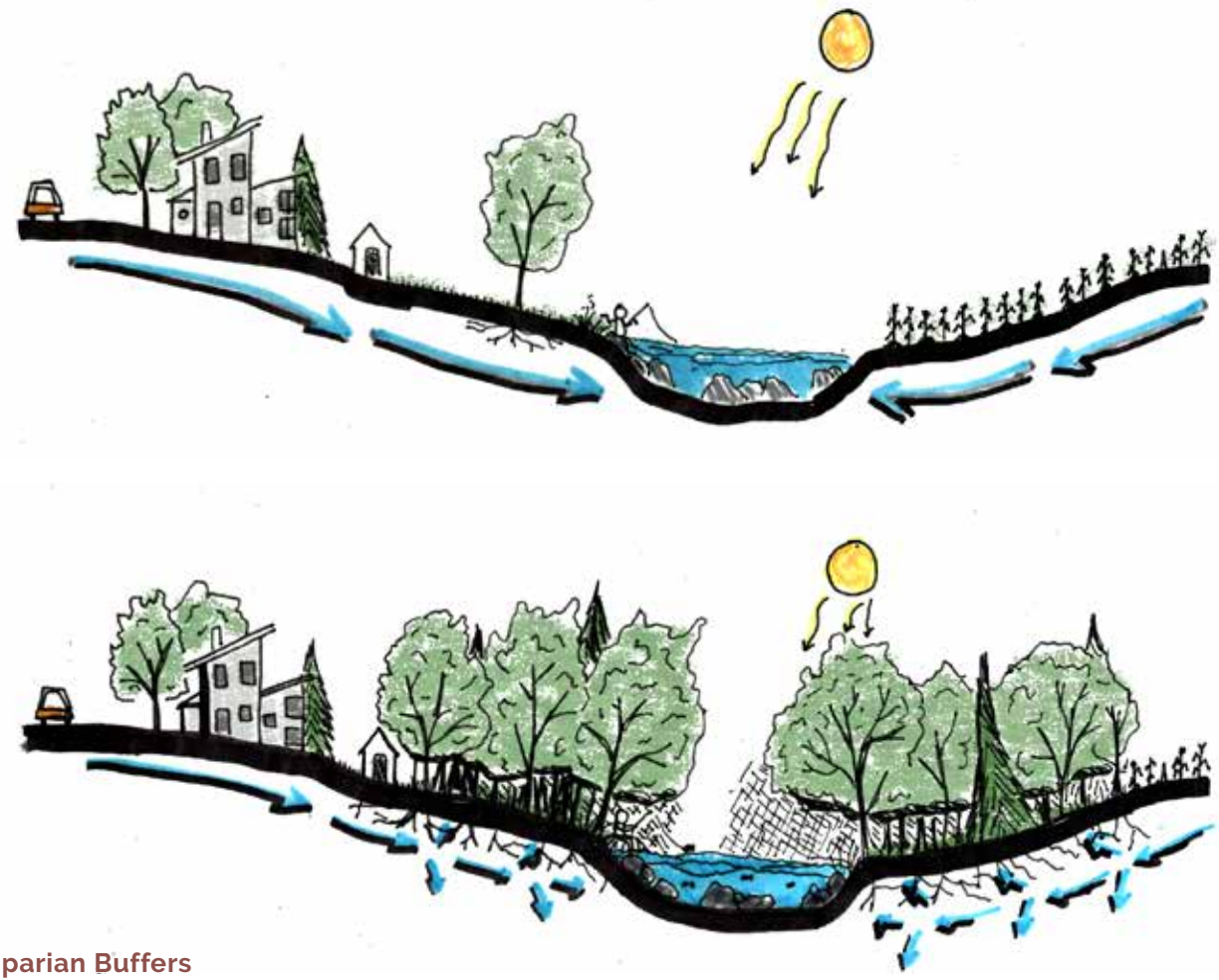
Plainfield Pond has reportedly seen an increase in use over past years. In 2021, the beach was temporarily closed due to *E. Coli* contamination in the water. The Massachusetts 2018 Integrated List of Waters designates Plainfield Pond as impaired (Category 4A) due to mercury contamination that makes fish consumption unsafe. It states that the mercury levels are due to atmospheric deposition, but there may be other unknown sources. The pond is quite shallow, with an average depth of only 5 feet, and according to one Plainfield resident, has a small water budget, meaning little water flows in or out of the pond. Therefore, any contaminants that enter the pond may take a long time to naturally flush out. Climate change may compound this issue by increasing storm runoff and contaminants that would enter the pond during larger storm events. In addition, warming temperatures may change the pond ecosystem, creating conditions that are less viable for some organisms and more so for others.

Riparian Buffers

While water quality is influenced by land cover and land use decisions across the watershed, the land immediately adjacent to streams and wetlands can have the greatest ability to contribute to or detract from water quality. Riparian buffers are vegetated corridors covering the land adjacent to wetlands and streams. Riparian buffers, particularly forested buffers, filter excess nutrients and contaminants from stormwater runoff. Trees and other layers of vegetation assist in slowing the movement of surface runoff, allowing it to filter into the ground before entering streams, reducing peak flows. Additionally, the roots of vegetation hold soil, assisting in streambank stabilization (Swanson et al., 2017). Altogether, riparian buffers help to protect water quality and mitigate impacts from floods.

The benefits of forested riparian areas go well beyond flood and erosion mitigation. Riparian areas are often zones of contribution, meaning the land around streams significantly contributes to groundwater supply. Impervious surfaces such as roads and driveways present the greatest barrier for riparian areas to serve this role, but even land cover that is considered pervious may still limit the amount of water that can infiltrate down into the water table. According to the Massachusetts Division of Ecological Restoration, "streamside forests cleared for cultivation or grazing are likely to experience a 33-67% reduction in water infiltrating the soil and entering the groundwater" (Cohen, 2014). Forests with a diverse understory have extensive root networks that create a more porous soil that is better able to increase infiltration rates into groundwater.

Riparian areas are also crucial for maintaining biodiversity. Trees along streams help shade the water and regulate its temperature. Cold water is able to hold more dissolved oxygen, which is a requirement for brook trout, salamander species, and many macroinvertebrates. In addition, forested corridors surrounding wetlands and streams offer important connectivity between aquatic and terrestrial habitat that many amphibian species rely on, as well as creating linear corridors that are important for animal movement.



Riparian Buffers

Riparian buffers slow, spread, sink, and cool stormwater runoff from roads, developed areas, and farms. This helps to maintain water quality and mitigate flood risk. Trees along brooks also help to shade and keep water cool, benefiting aquatic wildlife.

Wetlands Protection Act

The Massachusetts Wetlands Protection Act (WPA) safeguards wetlands, ponds, rivers, and streams as well as the adjacent vegetation in riparian areas from degradation and alteration. It extends protections to the land within 100 feet of wetlands, intermittent streams, and certified vernal pools (buffer zones), and land within 200 feet of perennial streams and rivers (riverfront areas). Work that is proposed within delineated wetlands and adjacent buffer zones and riverfront areas typically requires a permit by the local Conservation Commission.

Towns are given the authority to create their own wetland bylaws that can provide greater protections than the state law. The Plainfield Conservation Commission is currently in the process of trying to pass an expanded Wetlands Protection Bylaw, recognizing the importance of preserving water resources in the face of climate change. At the time of the drafting of this Plan, the new wetlands bylaw in Plainfield would:

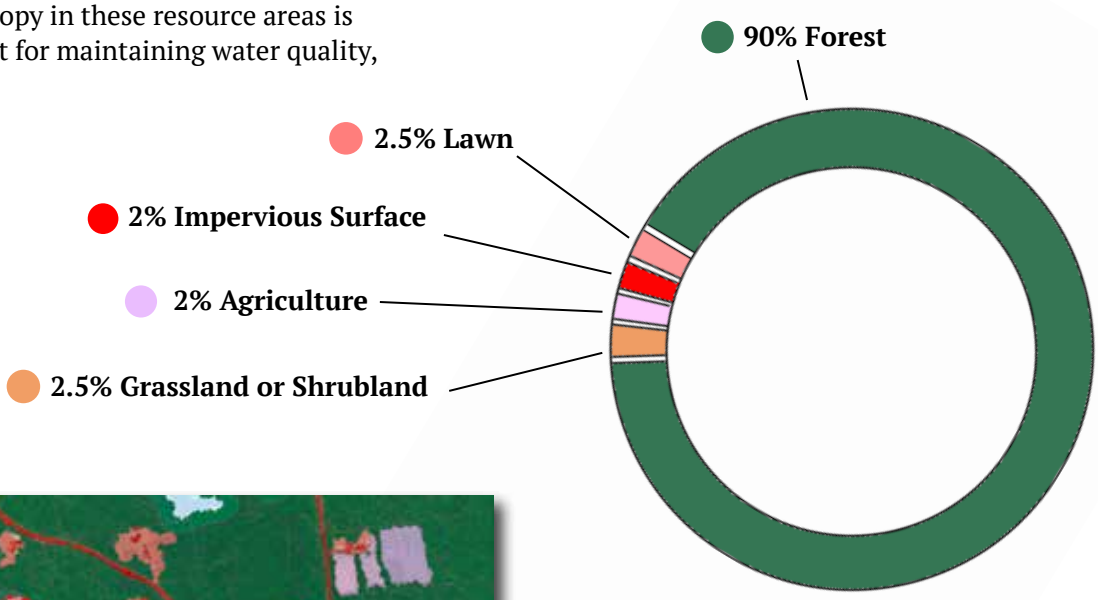
- Establish a "no disturbance zone" within 50' of the buffer zone closest to the resource area.
- Provide for an area of undisturbed vegetation extending up to 100' of the buffer zone or up to 200' of the riverfront area of perennial streams.
- Add a 100' buffer zone around isolated lands subject to flooding as defined by the WPA.
- Provide protection both for certified vernal pool habitat and potential vernal pool habitat.
- Extend the buffer zone from 100' to 200' from the mean annual boundary of the vernal pool.

The extension and increased protection of buffer zones and riverfront areas, collectively called resource areas, would further ensure the benefits of having vegetated riparian areas. A land cover analysis was conducted as part of this Plan to better understand the current condition of riparian

areas the Conservation Commission is trying to protect. This analysis used geospatial data to map out all of the proposed resource areas in Plainfield. This excluded the 100' buffer around isolated lands subject to flooding due to lack of available data. The analysis then calculated the percentage of various types of land cover within these areas.

In total, this process revealed that 90% of the 2,094 acres of land within the proposed resource areas is currently covered in forest. In addition, 2.5% is grassland or shrubland, 2.5% lawn, 2% agriculture, and 2% is impervious surface.

A 90% forest canopy in these resource areas is certainly an asset for maintaining water quality, aquatic habitat, and mitigating flood risk. While the amount of impervious surfaces was limited in total land cover, there is still potential for the new wetland bylaw to influence a significant number of properties with structures in resource areas. In total, 90 tax parcels had some kind of built structure within the resource areas. While farming is exempt from wetland bylaws restrictions, there were an additional 72 tax parcels with farmland within the resource areas.



Land Cover in Proposed Resource Areas

Proposed Resource Area
Vernal Pool
DEP Mapped Wetland
Stream

Map 3-4. Land Cover Analysis Example

Above: Different land covers were overlaid with the proposed protected resource areas around wetlands, streams, and vernal pools. This example shows an area near Bartlet Brook where a road (in red) crosses the stream. In the top right corner of the map, a farmland (pink) abuts DEP mapped wetlands (blue).

Right: This map shows the same area in satellite imagery .

CLIMATE CHANGE IMPACTS TO WATER

More Severe and Frequent Storms

Climate change is already bringing about new stresses on the Deerfield and Westfield River watersheds of which Plainfield is a part. For the past few decades, New England as a whole has seen more frequent and severe precipitation events. One of the most extreme examples occurred in 2011 when Tropical Storm Irene dumped an average of 10 inches of rain across Western Massachusetts (Bent et al., 2016). In Plainfield, Irene led to road washouts, failed culverts, and erosion along streams. Further downstream in the watershed, its impacts were even more dramatic. The Deerfield River rose 15 feet in just a few hours. Farmlands and towns were inundated with water. The Deerfield watershed recorded 274 landslides, which roughly matched the cumulative number seen in the area over the previous 30 years. With the trend of increased severity and frequency of rain storms forecasted to continue, Plainfield can expect to see more events like Irene in the future.

Watershed Impacts of Tropical Storm Irene

Left: Areas higher up in the watershed, such as Plainfield, saw road washouts, culvert failures, landslides and erosion. Photo from MASS DOT of road failure in Florida, MA after the storm.

Middle: Communities lower down in the watershed experienced larger-scale inundation, erosion, and sedimentation. Photo from USGS New England Water Science Center of the Deerfield River in Shelburne Falls.

Right: Severe erosion and landslides resulted in an enormous sediment plume that entered the Long Island Sound from the Connecticut River. Photo from NASA Earth Observatory.

Shifts in Precipitation Patterns Across Seasons

In addition to anticipated increases in total annual precipitation, the seasonal timing of precipitation is also expected to shift. More rain is projected to occur in winter and spring, while total summer precipitation is only expected to increase slightly. There is some uncertainty over what the impact of increased winter precipitation will bring, but there are concerns that it would lead to more severe flooding. Greater amounts of stormwater runoff would likely occur without a deciduous tree canopy and understory to slow water. Greater runoff rates and higher peak flows are also likely to occur if the ground is still partially frozen and thus less permeable (UMASS CAFE, 2017).

Hotter Temperatures and Drought

Although annual precipitation is predicted to increase, summers may experience increased dry spells due to hotter temperatures and longer durations between rainfall. The combination of dry conditions and hotter temperatures would decrease water availability for wildlife and people in Plainfield, create greater concern for wildfire, and further stress plant communities (UMASS CAFE, 2017).

Protect Riparian Forests and Vulnerable Waterways

The streams, wetlands, and ponds in Plainfield are better able to mitigate and adjust to the impacts of climate change when they are part of a landscape that helps to absorb, slow, and filter stormwater runoff. Protecting forests and other vegetation from development and other disturbance in areas that are adjacent to bodies of water will help to protect the health of Plainfield's waters from erosion and contamination as well as properties and structures from damaging floods.

The land cover analysis of riparian areas on pg. 48 revealed that much of the land surrounding streams and wetlands in Plainfield is already forested. Maintaining and enhancing this forest canopy into the future provides resilience in the face of multiple climate change forecasts.

Continue efforts to revise town wetlands bylaw for enhanced protection around water resources.

The town's effort to expand the wetlands bylaw is an effective way to keep forests and other vegetation intact around streams and wetlands. Stronger wetlands bylaws would make future development and disturbance near streams and wetlands less likely to occur. The expansion of buffer zones around vernal pools and the addition of a 50' no-disturbance zone in all resource areas ensures that riparian areas in Plainfield continue to support the region's flood resilience, protect water quality, and support biodiversity.

While the bylaws protect against future development and disturbance, they also should take into account the existing landscape. The land cover analysis on pg. 48 showed that 90 parcels in Plainfield have a structure within the proposed resource areas. The Conservation Commission should continue to engage residents to determine how these bylaws could both positively and negatively affect the people already living and working in resource areas. This is also an opportunity for educating the population on the important role they can play through stewarding the waters near their properties.

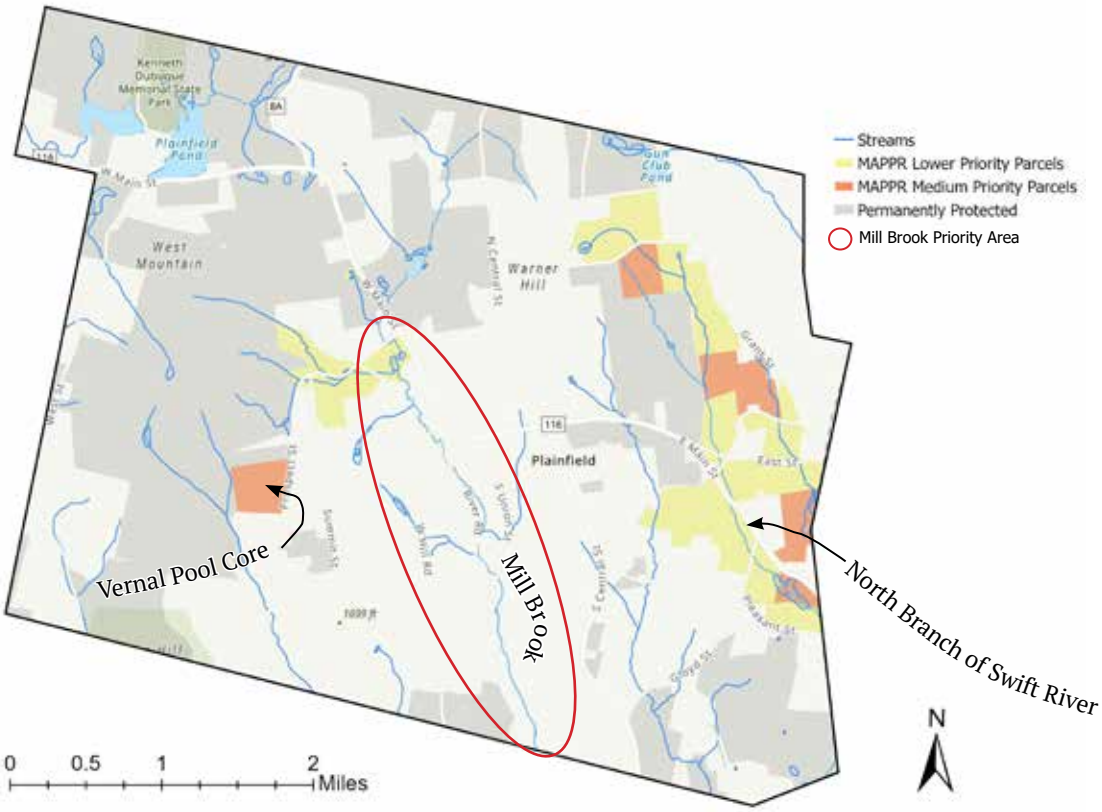
Consider land protection along vulnerable riparian areas.

Further protection of water resources should be considered in places that are particularly important for aquatic habitat or areas vulnerable to flooding and erosion. The Massachusetts Priority Parcels for Resilience (MAPPR) tool contains an aquatic model to help land conservationists prioritize parcels for protection based on a weighted analysis using data from BioMap2 wetlands, BioMap2 aquatic cores, BioMap2 vernal pool cores, surface water supplies, and wellhead protection areas. Running the aquatic model for Plainfield shows a number of parcels ranked as "medium priority" for conservation, predominantly along tributaries of the Swift River on the east side of town as well as around the vernal pool core north of Bartlett Brook.

In addition to protecting areas for aquatic biodiversity, it may also be appropriate to protect land that is vulnerable to flooding, or could potentially alleviate downstream impacts. The analysis of shallow bedrock and steep slopes on pg. 41 suggests that Mill Brook is particularly prone to flash flood conditions. In addition, the history of dams along its course and the close proximity of River Road to Mill Brook creates

greater concern for flooding on adjacent land. Properties along Mill Brook could be potential sites for conservation or river restoration projects that mitigate flood risk.

Land protection around water resources could be achieved through traditional conservation restrictions or, perhaps preferably, by methods that maintain the town's tax base and support greater equity in land access and ownership. Several tools to protect biodiversity and ecosystem health are outlined beginning on pg. 28 of this Plan, many of which could be employed to protect water resources. Such methods may include cultural easements, sustainable forest management programs, and carbon credit programs. If a conservation restriction is deemed appropriate, a new option might be a river corridor easement model that is being developed by the Franklin Land Trust. The easement program would help to maintain land along rivers in undeveloped states and allow river channel migration. Coordination with the Franklin Land Trust would be needed to understand how and if this model could be applied to Plainfield's smaller streams and work in conjunction with the wetlands protection bylaw.



Map 3-5. Important Areas to Protect for Water Quality and Aquatic Habitat

The MAPPR aquatic model designates parcels in Plainfield as medium priority (in orange) and lower priority (in yellow) for maintaining water quality and aquatic habitat. No parcels in Plainfield were identified as high priority by the MAPPR aquatic model. Other analyses showed areas that might be important to protect to increase flood resilience such as around Mill Brook (circled in red).

Advocate for state bill S.1875/H. 2831 to ensure compensation for watershed and ecosystem protection through the State Owned Land (SOL) PILOT program.

It is important to recognize that conserving land to protect biodiversity and watershed health can further constrain Plainfield's limited tax revenue. The Massachusetts State Owned Land (SOL) Payments in Lieu of Taxes (PILOT) program compensates municipalities with state-owned land within their borders. Non-profits such as land trusts are also encouraged to contribute to the program as well. However, a recent audit of the program has shown that it is largely underfunded, and that rural towns of Massachusetts rarely receive the stipend payments that they are supposed to. In order for Plainfield to continue responsible stewardship of its waters and landscape, it is important that this program be properly funded and supported. There are current efforts under way to fix the SOL PILOT program that Plainfield residents

and committee members can advocate for. Bill S.1875/H. 2831 aims to fully reimburse communities for the taxable value of state-owned land. This would include compensation for areas in Plainfield such as the Swift River Wildlife Management Area, Deer Hill Reserve, and Kenneth Dubuque State Forest. Plainfield does not qualify for the similar Watershed PILOT program, which only compensates communities with DCR properties that are specifically for water supply protection, of which there are none in Plainfield.

Connect farmers and other individual property owners with grants and programs to establish riparian buffers along streams and wetlands.

Expanding riparian forests would benefit water quality and habitat in places where lawns and farms encroach near rivers and wetlands. However, farmers and property owners without strong conservation or ecological convictions may not find much incentive to establish riparian buffers on their land. Others may economically depend on having this land in production rather than covered in forest.

However, there are several programs that fund the establishment of riparian buffers, including creating ones that are agriculturally productive. Agriculture in forested buffer zones will look different, often involving perennial vegetation and edible forest products. There are questions surrounding the economic viability of these practices; however, there are many funding sources to expand these approaches. Below is a partial list of funding sources and opportunities for farmers and landowners to establish riparian buffers and grow food in forested areas.

USDA NRCS Federal Grants and Assistance:

- *Agricultural Management Assistance Program (AMA):* helps landowners restore, enhance and protect forestland resources on private lands through easements and financial assistance.
- *Conservation Stewardship Program (CSP)*: designed to compensate agricultural and forest producers who agree to increase their level of conservation by adopting additional conservation activities. The program requires that all land be "in compliance with USDA highly erodible land and wetland conservation provisions."
- *Environmental Quality Incentives Program (EQIP)***:** Provides agricultural producers and non-industrial forest managers with assistance to plan and implement payment conservation practices. Payments for conservation improvements and activities cover income foregone, as well as costs incurred that are associated with project implementation.
- *Healthy Forest Reserve Program (HFRP):* helps landowners restore, enhance and protect forestland resources on private lands through easements and financial assistance.

Commonwealth of Massachusetts Grants and Assistance:

- *Agricultural Environmental Enhancement Program (AEEP)*: competitive reimbursement grant program that funds the implementation of agricultural conservation practices that reduce or prevent negative impacts to the environment.
- *Specialty Crop Block Grant (SCBGP)*: funds projects that aim to enhance the production and competitiveness of Specialty Crop industries in Massachusetts.

Consider conducting a fluvial geomorphic assessment to identify river restoration opportunities.

It may be appropriate to not only conserve land near the waters prone to flooding, but also conduct stream restoration projects designed to reduce flood impacts. Such methods could include adding more downed wood to slow and spread water in streams during storms, or restoring attenuation sites that would store water and allow rivers to drop sediment. Similar projects are being pursued in the South River Watershed in Franklin County, which are being funded by Municipal Vulnerability Action Grants. Wood addition projects in upland areas like Plainfield can be very effective at mitigating flood risks. However, further study would be needed to ensure the appropriateness of these applications in Plainfield streams. Fluvial geomorphology is the study of river process and form. Conducting a fluvial geomorphic assessment would assist in further locating areas vulnerable to flooding and what types of stream restoration projects might be effective at alleviating these risks.

Guide New Infrastructure and Development with Water in Mind

Update culverts and road crossings in areas at high risk of flooding and erosion.

Degraded and undersized culverts in Plainfield increase flood vulnerability and fragment aquatic habitat. The Massachusetts Stream Crossing Handbook outlines different types of culverts and crossings that effectively mitigate these concerns, including bridges, open bottom arches, and culverts that span and are sunk into the creek bed. The town should prioritize replacing the culverts in poor condition as identified in the 2020 culvert assessment based on these standards.

Outside funding is almost certainly needed to take on the challenge of replacing Plainfield's culverts. Culverts can be financed through Chapter 90 funding, or as part of larger MassDOT projects. Plainfield can also use information from its culvert study to apply for funding under the state's Culvert Replacement Municipal Assistance Grant Program, which focuses on projects that improve climate resilience and ecological health. In addition, the town is eligible for Municipal Vulnerability Preparedness Action Grants, which can be applied to culvert replacement projects. One culvert in Plainfield has already been replaced using MVP Action Grant funds. It should be acknowledged that these grants do not always completely fund project costs and that grant writing itself requires significant time and resources.

Characteristics of a Well-Designed Stream Crossing

- Large size suitable for handling high flows
- Open-arch design preserves natural stream channel
- Crossing span helps maintain dry passage for wildlife
- Natural substrates create good conditions for stream-dwelling animals
- Water depth and velocity are comparable to conditions upstream and downstream

(Massachusetts Stream Crossing Handbook, 2018)

Study of long term payoffs of right-sized culverts

A challenge of upgrading stream crossings is the high up-front cost for construction. Plainfield, like other small towns, has a limited budget for road infrastructure, which often gets spent on road maintenance with little to spare for new infrastructure. Larger, well-functioning culverts typically have higher up-front costs for construction, design, and materials. However, recent studies have shown that over the long run, upgraded culverts are likely to provide cost savings. The Massachusetts Division of Ecological Restoration compared costs of replacing culverts with similarly sized structures versus upgrading the crossings to meet the 2014 Massachusetts Stream Crossing Standards. Over a 30-year period, the upgraded culverts were 38% less expensive than the similarly sized replacements. While the initial cost was less, the same-size structures needed such frequent repairs and replacement that they required greater spending over time. According to the study, many upgraded crossings that take climate forecasts into account should last 50 years or more (Massachusetts Division of Ecological Restoration, 2015).

Consider adding stormwater bylaw language that requires low impact best management practices for new construction.

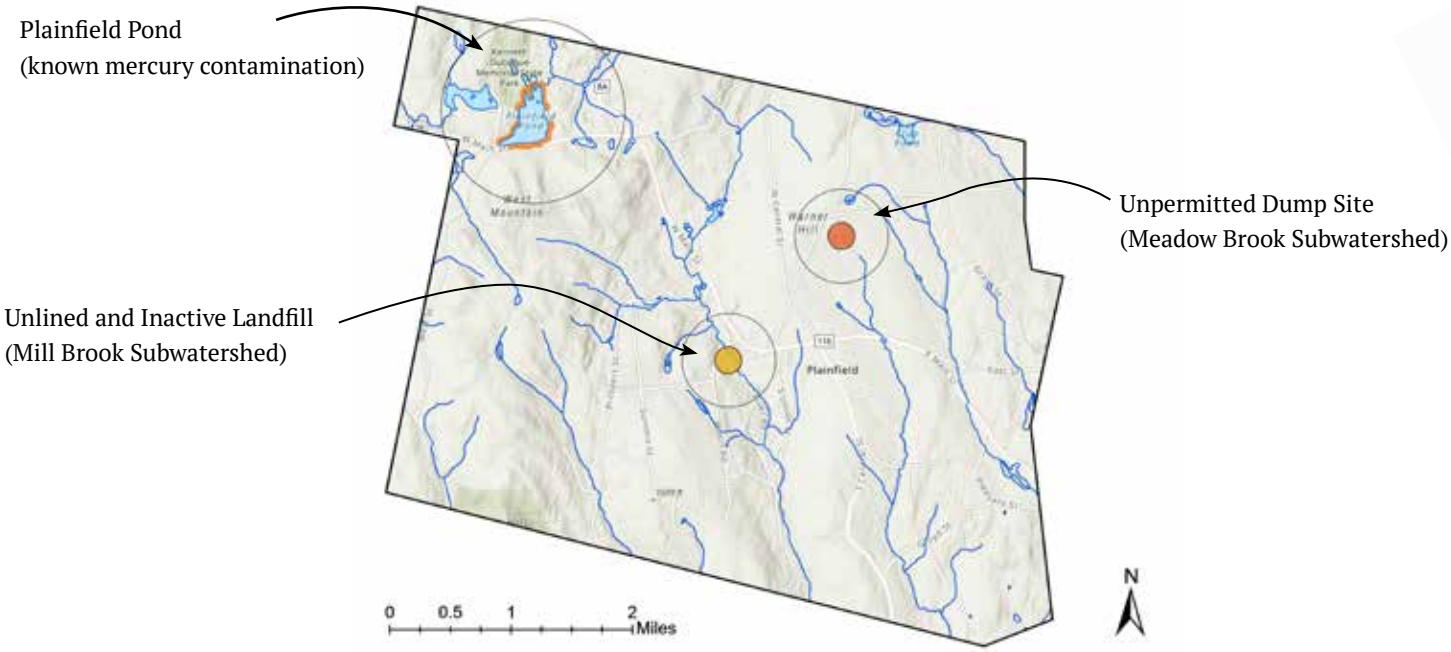
One way to diminish the impact that future homes, roads, and developments have on water resources is to adopt a stormwater bylaw. Stormwater bylaws require developers to adhere to low impact development (LID) practices which protect surface water from contaminated runoff and replenish the groundwater supply. The nearby Town of Deerfield adopted a wetland bylaw that could similarly be used in Plainfield. It requires a stormwater permit for altering land within the town boundaries. In addition it requires that the amount of stormwater runoff is equal to or less than pre-development conditions and that the quality of stormwater runoff is equal to or better than pre-development conditions.

Identify and Reduce Contaminants in Surface Waters and Groundwater Supply

Consider the Water Quality Management Planning Grant Program to conduct full-profile water quality testing at key surface and groundwater locations.

Through stakeholder meetings and reviews of previous plans, several other concerns related to the sustainability of Plainfield's water resources have emerged. For one, previous land use has raised concerns about possible contamination in surface water and groundwater. In stakeholder meetings, it was noted that an unlined, inactive landfill is located adjacent to Mill Brook close to Main Street. Another inactive dump site is located near the beginning of Meadow Brook. Increased recreational use of Plainfield Pond has caused the beach to be closed at least once in recent years due to *E. Coli* contamination. It is unclear exactly how these old landfills and the pond impact Plainfield waterways and drinking water, as most residents do not test their wells regularly.

The Town and residents would benefit from testing the water in wells and in surface water near these sites to better understand how these sites are affecting water quality. Section 604b of the Federal Water Protection Act established the Water Quality Management Planning Grant Program, which could allow Plainfield the funds to conduct a study to assess these risks. Grant funds through this program can be used for "the determination of the nature, extent, and causes of water quality problems and determination of pollutant load reductions necessary to meet water quality standards" (Massachusetts DEP website).

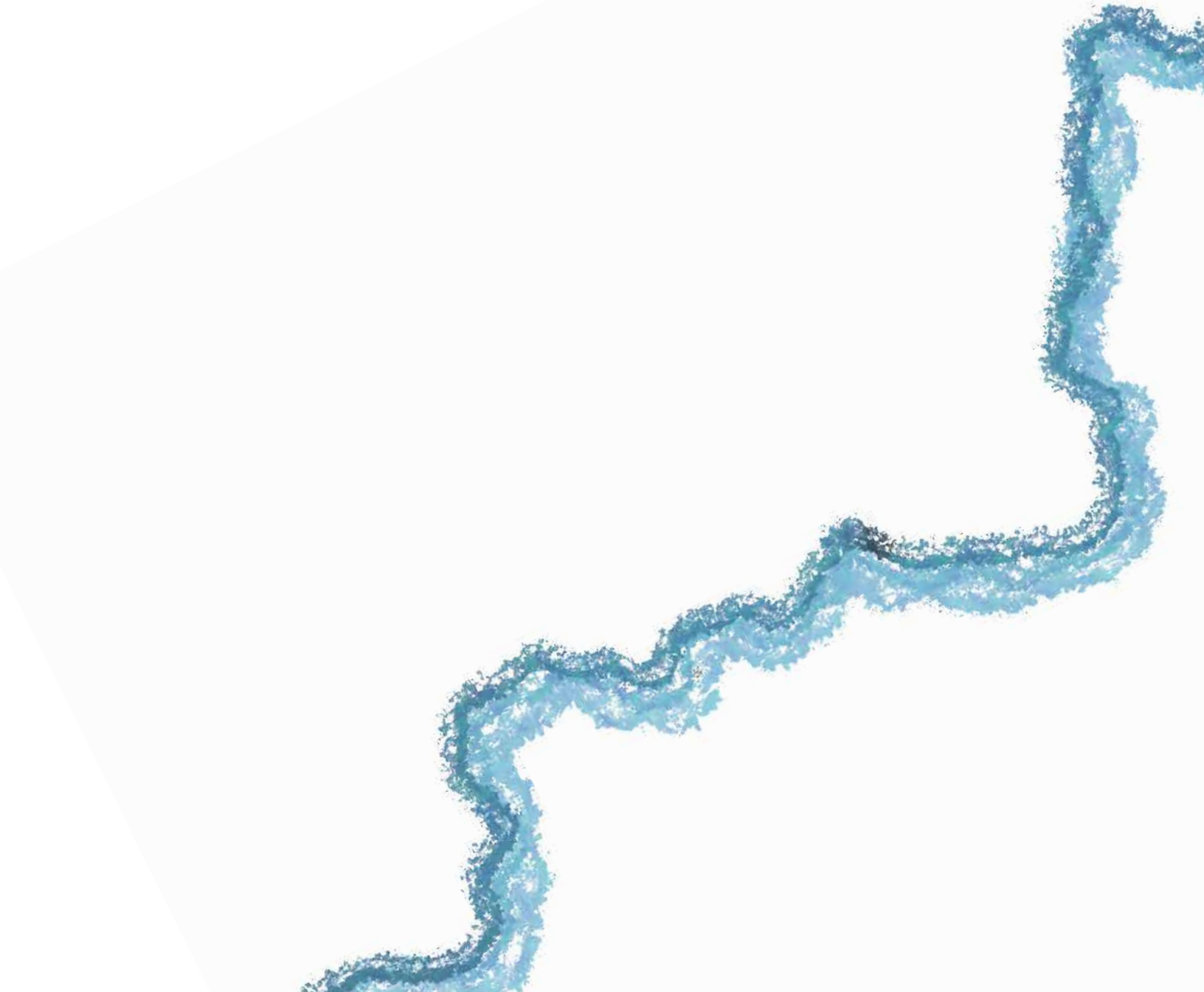


Map 3-6. Areas to Prioritize Water Quality Testing

Plainfield Pond is highlighted in orange in the northwest corner of town. The unlined and inactive landfill is represented by the yellow circle located directly next to Mill Brook. The unpermitted dump site is represented by an orange circle, located near the headwaters of Meadow Brook.

Develop a salt reduction program including the establishment of reduced salt areas near important water resources.

The Pioneer Valley Planning Commission outlines methods towns can take to reduce salt contamination in water resources from winter road runoff. A road salt reduction program identifies and prioritizes segments of roads on which to focus salt application reduction and salt alternative policies. These segments of road would typically be close to a sensitive waterway or other water resource. Towns in Massachusetts have the right to pass regulations and bylaws that affect road salt application within their borders. A reduced road salt area would often be accompanied by signs to alert drivers of possible changing conditions.



Chapter 4

Agriculture & Food Systems

"Farmland preservation, more than any other management activity, will likely have the single greatest impact in stabilizing and reducing future emissions."

Source: Nicholas Institute for Environmental Policy Solutions
Report: Greenhouse Gas Mitigation Opportunities in California Agriculture

Via American Farmland Trust (Farmland.org)

SECTION SUMMARY

The term "food system" refers to the various elements and interactions along the chain between food production and consumption. Having reliable food systems is a necessary part of supporting the Plainfield community in the face of climate change. Food systems, especially globalized ones, are easily affected by sociopolitical and environmental disruptions, which can impact food security for those who rely on outside sources of supplies. At the same time, the production, processing, and transportation of food can contribute to global climate change through carbon emissions from certain practices.

Plainfield has a history of agriculture and continues to practice some farming today. In addition, residents source much of their food from outside of town and are mainly dependent on large chain grocery stores, linking them to national and global supply chains. Typical soils in Plainfield are fairly shallow and rocky, not good for cultivation. Only a small percentage of the town has productive soils, and of that, much has been reclaimed by forest as historical farming operations declined. Other areas of suitable farmland soils have been developed with houses or other structures.

Climate change can affect all aspects of the existing food system in Plainfield through both local and global disruptions. To build a resilient food system in Plainfield, it will be necessary to explore both local and regional options, including preserving and enhancing local food production capacity and determining Plainfield's potential role in a larger-scale collaborative approach. At the same time, the carbon emissions potential of the food system must be minimized to help mitigate climate change effects. Obtaining food from nearby sources is one strategy to reduce transportation-related emissions; another is to utilize climate-friendly agricultural practices that reduce emissions and/or actively sequester carbon.

This chapter will describe the importance of food security, the characteristics of Plainfield's food system and agricultural capacity, and how food sourcing and agricultural practice decisions can both affect and be affected by climate change. A list of recommendations outlines possible strategies for building the resilience of Plainfield's food systems in an uncertain future.

Photo credit: Plainfield Historical Society

Farmer hoeing potatoes

Agricultural activity has been a part of the Plainfield area identity for generations.

Food Systems and Climate Change

The United States Department of Agriculture (USDA) defines food security as the ability to obtain and use sufficient amounts of safe and nutritious food (Brown et al., 2015), requiring that food be simultaneously **available**, **accessible**, and **usable**. Rising sea levels, alterations in rainfall and temperature patterns, and unpredictable and intense weather events affect all aspects of the food system, from production to transportation to purchase price.

An assessment report on climate change and food systems produced by the USDA concluded that climate change is likely to reduce food security through disruptions in production, local availability limitations and price increases, interrupted transportation networks, and reduced food safety (Brown et al., 2015). In other words, food may be less available (physically), accessible (due to price), or usable (food may be unhealthy, or people may be unfamiliar with foods that are available). Globalized food systems such as those in the United States may be particularly vulnerable since disruptions occurring in either domestic or foreign production may impact any of the three elements of food security—as was observed with widespread food availability interruptions during the COVID-19 pandemic.

While food security is an important part of developing community climate resilience, food systems themselves can contribute to climate change through greenhouse gas (GHG) emissions. The United States Environmental Protection Agency (USEPA) estimated that 10% of the United States' 2019 GHG emissions came from agriculture. Of that, soil management accounted for just over half (USEPA, 2021). Appropriate use of fertilizers, avoiding loss of natural vegetation, and improving management practices through methods like reduced tillage, grazing management, and maintaining cover vegetation have the potential to reduce emissions and increase carbon sequestration in this sector (USEPA, 2021; AFT, 2022). Additional emissions are produced from industrial and transportation processes related to food, so minimizing the amount of processing required and the distance that food must travel between producer and consumer are both effective ways of reducing associated GHGs.

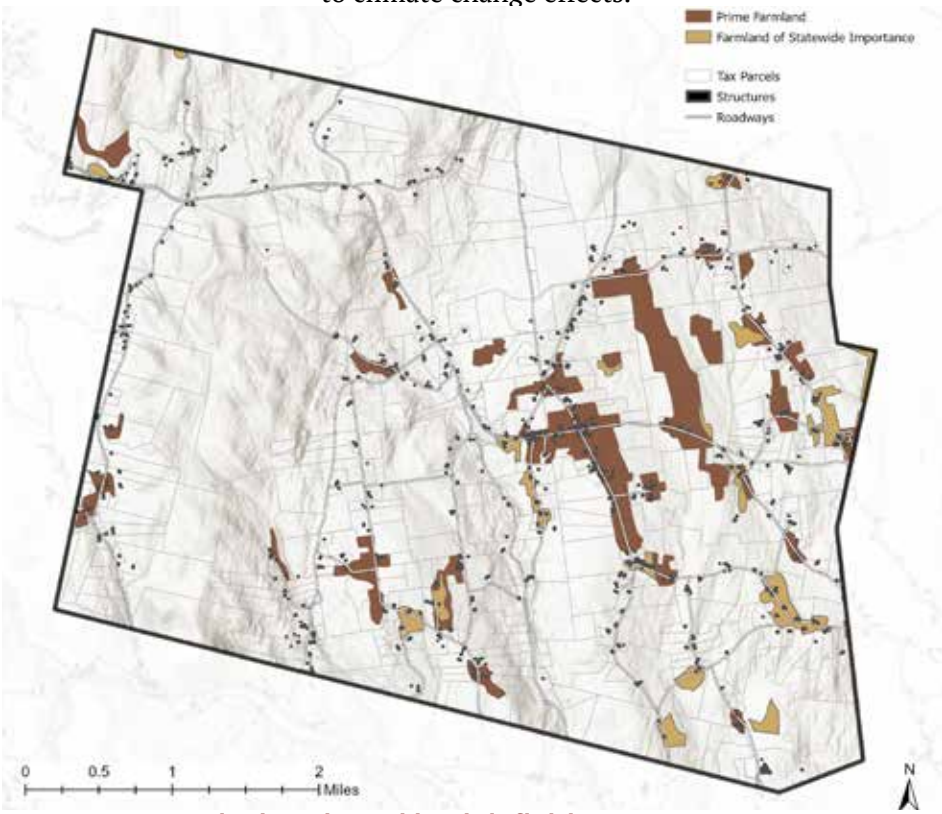
As Plainfield is a town that both engages in agriculture and sources much of its food from outside its borders, the structure of its food system influences GHG emissions and (potentially) mitigation efforts in the region. At the same time, the existing system is vulnerable to climate change effects.

Food security requires that food be simultaneously:

- **Available**: that it exists in a particular place at a particular time
- **Accessible**: that people can access that food through economic or other means
- **Usable**: that people can utilize the food that is available and accessible to them

And that each of these components be **stable** over time.

Climate Change, Global Food Security, and the U.S. Food System, 2015



Map 4-1. Important Agricultural Land in Plainfield

Distribution of prime farmland soils (dark brown) and farmlands of statewide importance (light brown) in Plainfield, including existing structures, roads, and parcels.

Farms and Food in Plainfield

Agriculture

The area now known as Plainfield has a long history of cultivation, beginning with native inhabitants of the region. Like much of Massachusetts during the seventeenth and eighteenth centuries, colonial settlers implemented broadscale clearing of large portions of the landscape for cultivation and pasture. By the mid-1800s, however, both farming and related stream-powered mill industries were on the decline. Subsequently, much formerly cleared land has now reverted to forest (Figure 4-1).

Currently, approximately eight percent of Plainfield's land cover is used for agricultural purposes, including croplands and pasture. These areas represent the bulk of non-forested land in Plainfield.

Plainfield has regionally typical upland soils—primarily glacial till, stony and well-draining, with shallow bedrock—which can pose an obstacle for farming; nevertheless, areas of productive soil do exist. The Natural Resources Conservation Service (NRCS), in combination with the Department of Agriculture, classifies three categories of important farmland, two of which occur in Plainfield: Prime Farmland and Farmland of Statewide Significance (see sidebar). Map 4-1 shows the distribution of important farmland within town boundaries. At a total of 1,060 acres, these lands represent less than 8% of the total town acreage; this is significantly less than many nearby municipalities (Map 4-2).

There are two particularly notable areas of important farmland soils in Plainfield, shown in

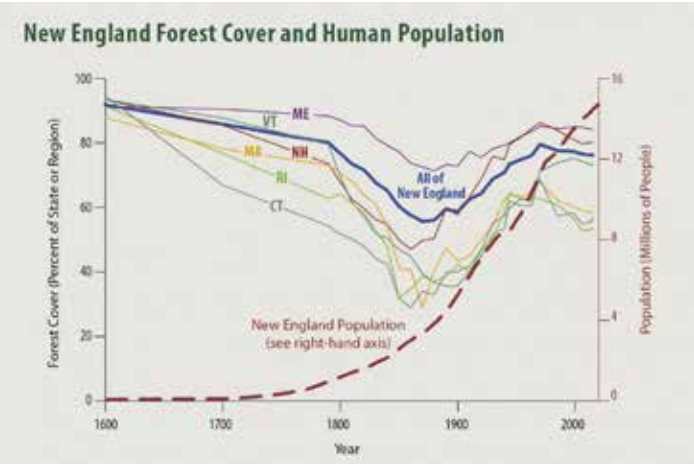


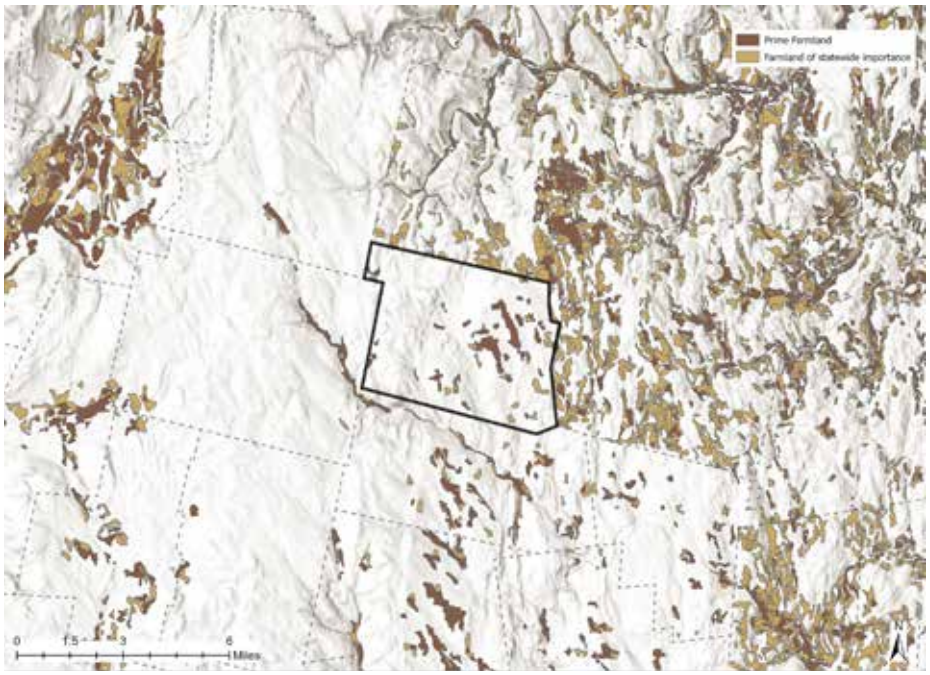
Figure 4-1. Historical Forest Cover in New England

Forests were largely cleared for agriculture in New England by the mid-1800s, then rebounded as fields were abandoned (Foster et al., 2017)

Important Farmland Types in Plainfield

Prime Farmland: Land that has the best combination of physical and chemical characteristics for economically producing sustained high yields (781 acres)

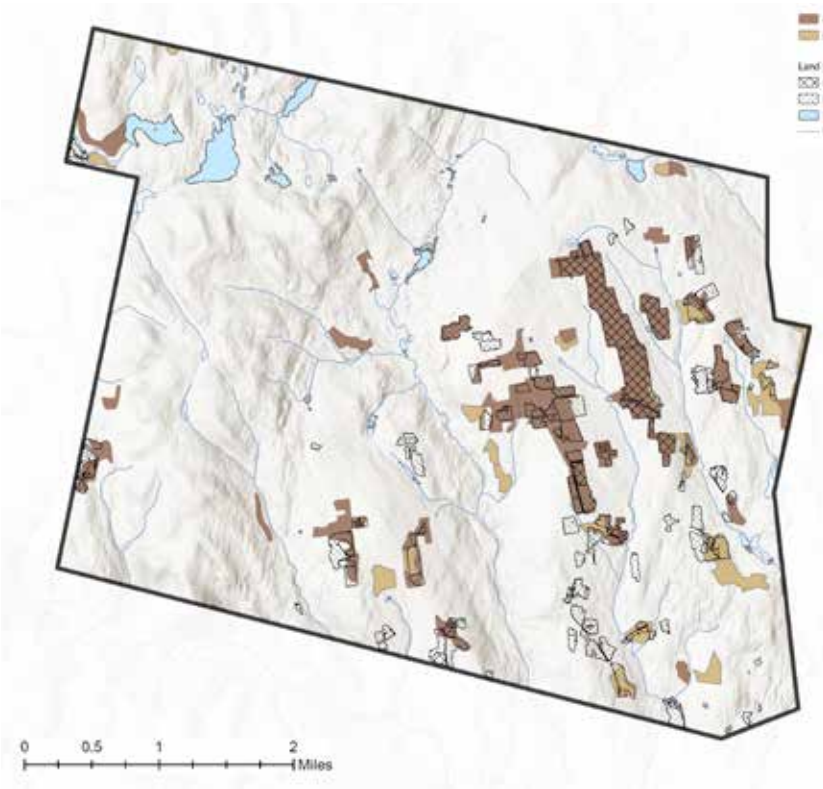
Farmland of Statewide Significance: Land in addition to prime farmland judged to be important for production by the state agency; nearly prime farmland in characteristics and capable of economically producing high yields (279 acres)



Map 4-2. Important Agricultural Land in Plainfield and Surrounding Region

Prime farmland and farmland of statewide importance in Plainfield and surrounding municipalities.

the larger brown areas in Map 4-1. The first is located in the northeast part of town and lies almost completely under several larger contiguous parcel lots. The second area is located slightly to the west towards the center of town. The presence of several major roadways and denser development there mean that this area underlies many smaller and separately owned parcels and has a greater amount of built infrastructure and impervious surface, which could impede its use for agricultural production.



Map 4-3. Agricultural Activity in Plainfield

Cultivated areas in Plainfield generally fall on areas classified as important farmland soils.

According to 2016 high-resolution land cover data from NOAA, most of the current agricultural activity in Plainfield involving cultivation does appear to take place on soils categorized as important farmland, while pasture/hay use is more varied (Map 4-3).

Approximately 50% of Plainfield's important farmland is actively used for agriculture, i.e., crops or pasture/hay. Another 6% is classified as "grassland," which refers to areas dominated by grass or herbaceous vegetation not subject to intensive management such as tilling (though they can be used for grazing and thus may partially contribute to agricultural use). About 31% is forested, while 13% is under some form of residential or commercial development or impervious surface (such as roads) (Figure 4-2).

Protected Farmland

Roughly half of Plainfield's important farmland soil is protected in perpetuity via Agricultural Preservation Restrictions, which create a permanent deed restriction stipulating that the property must not be used or developed for any purpose that would negatively affect its agricultural viability (Map 4-4). APRs are typically purchased with state funds (e.g., by the Massachusetts Department of Agricultural Resources [MDAR]). Specific terms, allowable uses, and other elements are recorded in each APR and may vary between parcels depending on landowner goals. In some cases, landowners may also petition MDAR for a special permit or certificate of approval to use the land for something not previously authorized under the APR. As of 2018, an additional 975 acres (32 parcels/18 owners) in Plainfield were enrolled in the Massachusetts Chapter 61A program, which offers landowners a property tax break in exchange for keeping land actively involved in producing agricultural or horticultural products. Although there is a tax penalty if the land is sold for or converted to a non-agricultural use, the penalty only applies if the conversion happens within ten years following entry into the Chapter 61A program, so this qualifies as only temporary protection.

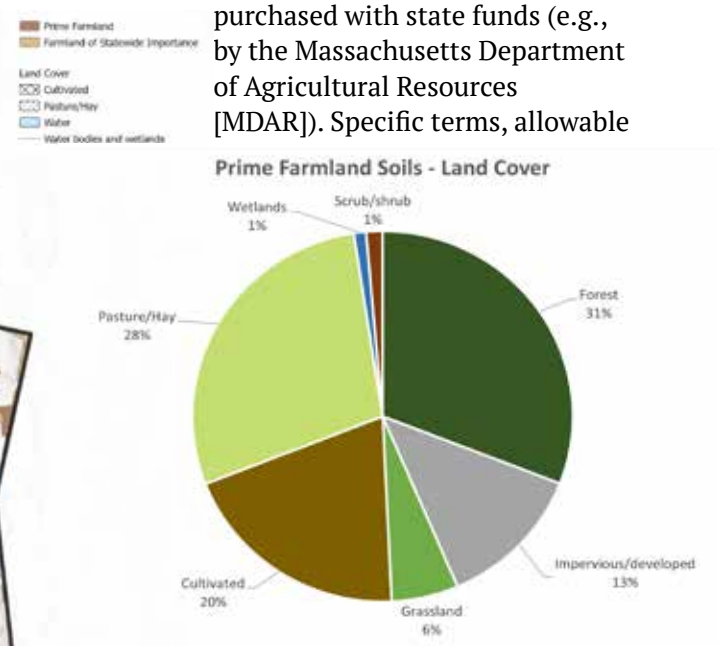
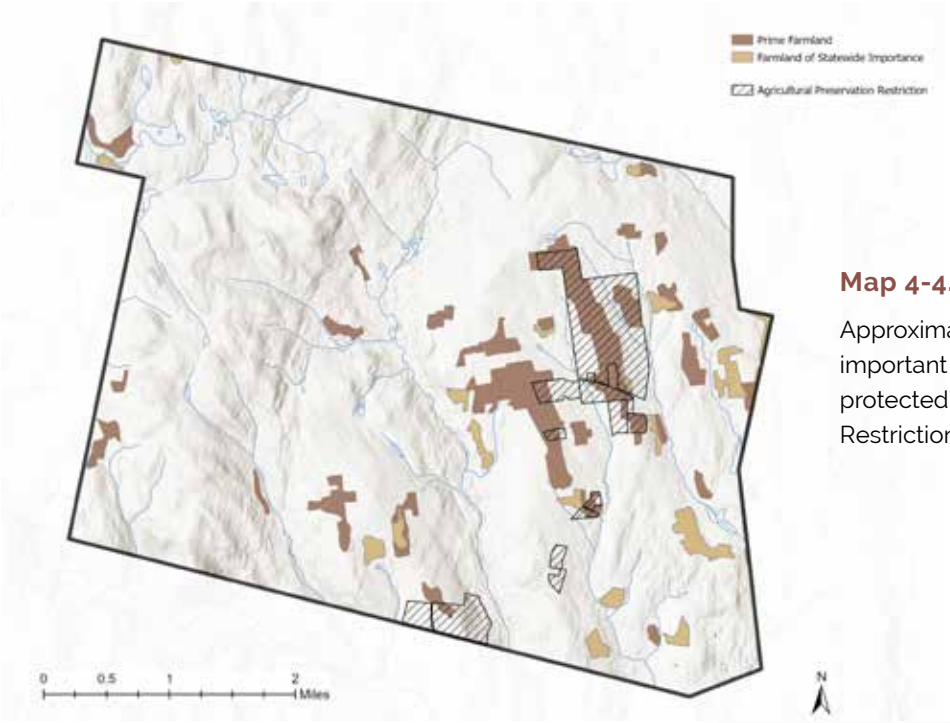


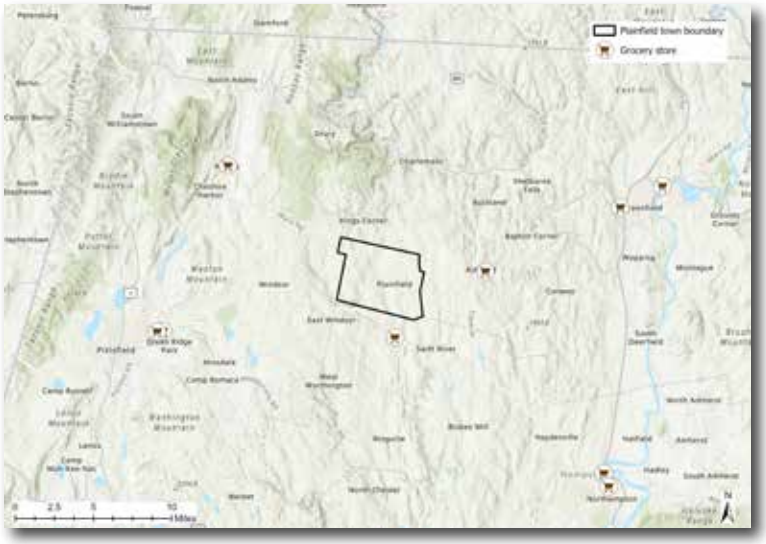
Figure 4-2. Land Use on Important Agricultural Soils in Plainfield

Most important farmland areas in Plainfield are cultivated, used for pasture or hay, or are forested.



Map 4-4. Preserved Farmland

Approximately 50% of Plainfield's important farmland soils are permanently protected under Agricultural Preservation Restrictions..



Map 4-5. Proximity of Grocery Stores

Plainfield has no grocery stores of its own. Large supermarkets are more than fifteen miles from town.

Getting Food

Some Plainfield farms have farm stands that operate during the summer; however, since the "Plainfield Mall" (a small convenience store) recently closed, there are no longer any opportunities for Plainfield residents to purchase food year-round in town. Some food supplies are available at a small cooperative grocery in Cummington (approximately five miles from the heart of Plainfield) or at the general store in Ashfield (nine miles away). However, residents must drive more than fifteen miles to reach full-sized supermarkets in Adams, Pittsfield, Greenfield, or Northampton (Map 4-5). Several residents reported in stakeholder meetings held during the development of this Plan that they felt the cooperative had limited inventory and was very expensive, and they preferred to shop at the larger supermarkets—usually when already traveling out of town for work or other reasons—and pick up sufficient supplies for a week or more. They indicated a belief that this was true for most of Plainfield's population.

Plainfield also has one existing community garden—Raspberry Hill—which was formed in 2011 on the Guyette Farm property by agreement with the Franklin County Land Trust to use part of the property for food cultivation. This organization offers approximately 10,000 square feet of garden plots, and also hosts educational workshops, seed-saving programs, school programming, and food donations. It is unknown to what extent this resource is utilized by local residents. Anecdotal evidence from stakeholder comments suggests that many town residents may also cultivate small vegetable gardens on their own properties.

Building a Resilient Food System in Plainfield

A New England Food Vision, released in 2014, evaluated food systems in New England through the lens of future resilience and proposed an aggressive goal of building the capacity to meet 50% of New England's food demand through local production by 2060 (Donahue et al., 2014). This vision is currently being updated based on an interim goal of producing 30% of New England's food supply in the region by 2030. The study proposes several possible scenarios for a future in which New England pursues a collaborative regional food system through adaptation and transformation of production, distribution, and consumption, and stresses the importance of supporting strong local agriculture.

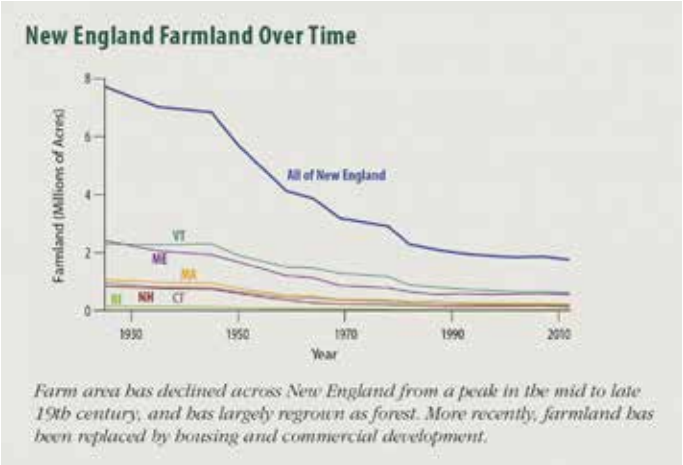


Figure 4-3. Historical farmland coverage in New England

Farmland acreage has been steadily declining in New England since the mid-1800s (Foster et al., 2017).

Massachusetts, like the rest of New England, has been steadily losing agricultural land throughout the twentieth century (Figure 4-3). As the total acreage of Massachusetts land in farming has decreased, so has the average size of individual farms, now holding fairly steady at almost 70 acres since 2007 (Fitzsimmons, 2019). Preserving the capacity for food production on these remaining farmlands will play a critical role in achieving increased food security in New England states under scenarios such as those proposed in *A New England Food Vision*. This is a critical time to evaluate agricultural protection: farmland values in Massachusetts rose a stunning 21% between 2020 and 2021 and are currently the third highest in the country at an average of $13,700/acre (USDA, 2021) (Figure 4-4). A recent report published by the American Farmland Trust cited pressure from low-density development as a critical threat to

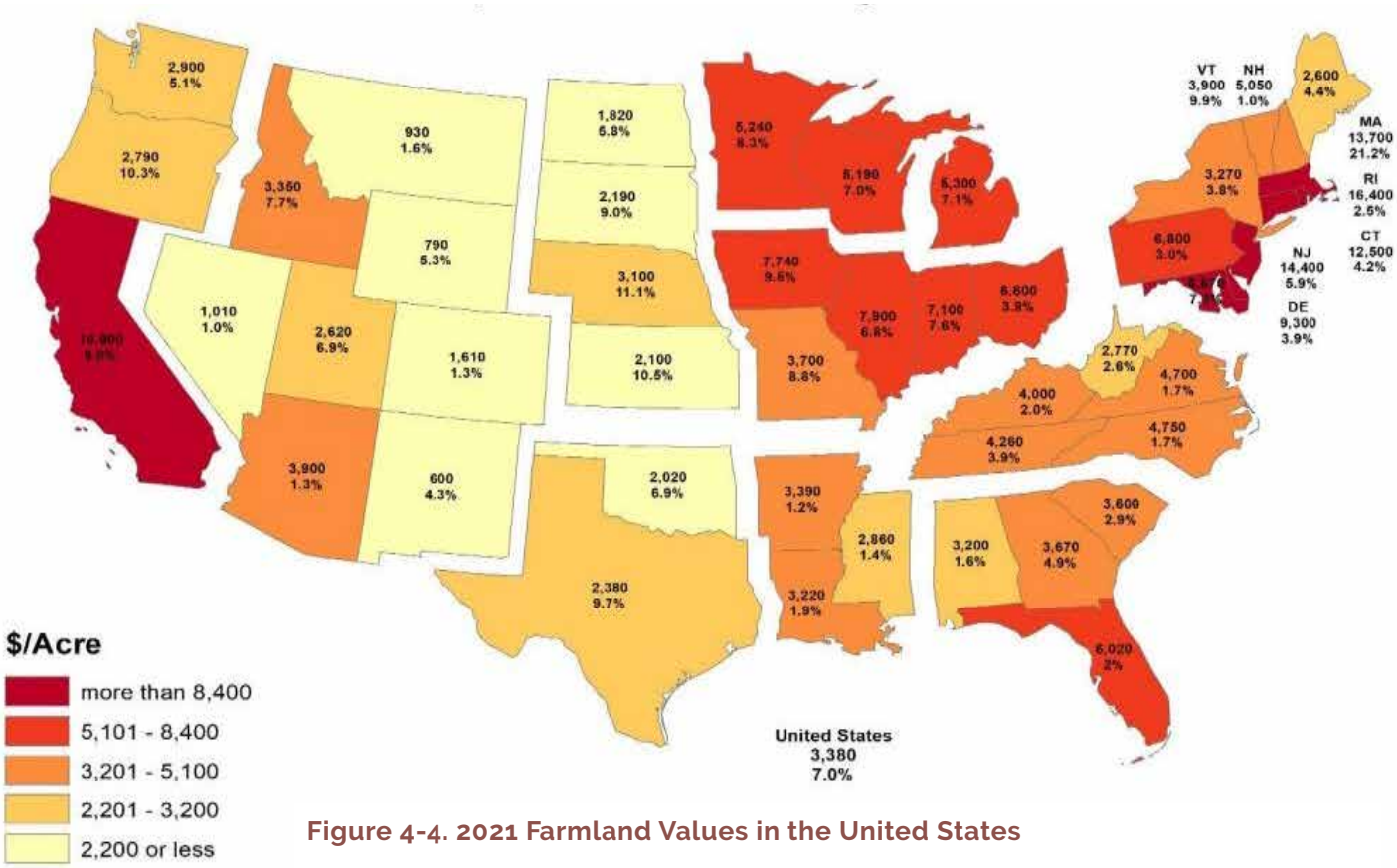


Figure 4-4. 2021 Farmland Values in the United States

Farmland values in Massachusetts increased sharply between 2020 and 2021 (USDA, 2021)..

agricultural land use in New England (Pottern and Barley, 2020). Farmlands are often open and relatively flat, making them highly attractive to developers, and high real estate values make it equally attractive for owners to sell. Under Chapter 61A, the local town is given the first opportunity to purchase a parcel being put on the market, but in Plainfield's case it is highly unlikely that the Town would have the funds to match a private developer's offer. High real estate values also make it difficult for prospective farmers to obtain land of their own, or even local housing that would enable them to work for or lease land from other farmers.

Plainfield's current dependence on food purchases from outside its borders make it potentially vulnerable to disruptions that impact either the delivery of food to the nearby supermarkets or the ability of Plainfield residents to travel to—and/or afford to shop at—these locations. Since larger supermarket chains are likely to be supplied by national and even global sources, potential types of disruptions are correspondingly broad and well beyond Plainfield's control. Other types of disruptions may be more local—such as bad weather interrupting truck traffic on I-90 or a bridge washout preventing residents from leaving town—yet equally difficult to control. Increasing food production and local sales within town boundaries could improve food security for Plainfield's population by reducing the impacts of these outside events. However, as discussed above, Plainfield has limited areas of soils suitable for agricultural production and utilizing the areas it does have to their fullest extent for large-scale production is likely to require clearing of woodlands. Alternatively, cultivation could be attempted on subprime land with greater slopes and/or poorer soil quality. Either of these approaches could result in negative environmental impacts, especially if not done responsibly.

Raspberry Hill Community Garden

Climate Change Threats to Farmland

- Higher average temperatures and more variable temperatures
- Flooding and damage from severe storms and increased precipitation
- Unpredictable precipitation patterns
- Soil degradation from higher temperatures and increased erosion
- Increased disease and weed pressure
- New and increasing non-native pest threats

At the same time, climate change projections for the region (see pg. 7) have the potential to impact the viability of farming in Plainfield in a variety of ways. Increasing temperatures may extend the growing season. However, Plainfield's relatively shallow bedrock and well-draining soils combined with variable precipitation patterns may result in unpredictable soil moisture and water availability—either too much or too little—that will cause stress to crops. Increased frequency and intensity of storms could result in crop damage. Warming temperatures may cause some crops to become less viable in Plainfield while others become more so; similarly, threats from existing or new insect pests, pathogens, and non-native plants may get worse. Some residents noted in stakeholder calls that they have already observed "bug season" lasting longer. Others expressed concern over the long-term health of native pollinator populations in the face of climate change.

These impacts are not unique to Plainfield; farmlands throughout New England are likely to face similar challenges under changing climate conditions. The possible scenarios laid out in *A New England Food Vision* acknowledge that complete food self-sufficiency (if maintaining current food consumption preferences) is not practical for New England, let alone an individual state or town, and that collaborative action will be necessary to achieve collective impact. While focused primarily on food production, all the envisioned scenarios included components of forest conservation, planned development, and support of diverse local economies. Whether or not the specific goals of the *Vision* are achievable for New England, Plainfield should consider its potential capabilities, strengths, and limitations in a broader regional context when developing a strategy for improved food security.

Agricultural preservation in Plainfield should have multiple objectives: to maintain and improve the economic viability of existing farms, to protect and enhance the health and productivity of soils currently being used for agriculture, and to avoid development or impacts on other land with productive soils that might destroy its ability to support cultivation in the future.

Implement strategies from the MA Smart Growth / Smart Energy Toolkit to preserve agricultural land

The MA Smart Growth / Smart Energy Toolkit published by the EEA lists several options and incentives for agricultural preservation. Plainfield has already implemented several of these strategies, including:

- **Establishing Agricultural Preservation Restrictions:** As described above, APRs are permanent deed restrictions that preserve parcel viability for agricultural use. Approximately half of Plainfield's active agricultural land is protected under APRs (Map 4-4).
- **Participating in Chapter 61A:** Participating landowners are given a tax break in exchange for maintaining their land in agricultural use. As of October 2018, eighteen Plainfield landowners were taking advantage of this program to reduce their property taxes (as reported by the town assessor in the Hazard Mitigation Plan).
- **Establishing Agricultural Commissions:** Agricultural Commissions are groups formed via local bylaw that serve as advocates for local farms. Plainfield's Agricultural Commission bylaw was adopted in 2006. The Commission consists of five members and has a charter to promote and facilitate agriculture in town, work to preserve prime agricultural land, and "pursue all initiatives appropriate to creating a sustainable agricultural community and preserving the rural character of Plainfield" (Town of Plainfield, 2016).
- **Establishing community gardens:** Community gardens provide residents an opportunity to grow food who may not have access to land otherwise. Plainfield currently has one community garden, which has been operating since 2011.
- **Asserting Right-to-Farm:** The "Right to Farm" is given to all Massachusetts residents under the state constitution. Communities may formally announce their support for this right by passing a Right-To-Farm bylaw stating that agricultural activities are allowed and encouraged and making current and prospective residents aware of the potential for encountering agricultural activities (noise, smell, etc.). Plainfield has taken the additional unique step of explicitly specifying support for "generally accepted responsible agricultural practices" in its bylaw.

Additional strategies recommended in the Smart Growth / Smart Energy Toolkit that Plainfield could consider include the following:

Participation in the Farm Viability Enhancement Program (FVEP).

FVEP is a state program administered through MDAR designed to improve profits and environmental integrity of participating farms through the development and implementation of Farm Viability Plans.

What is Regenerative Agriculture?

Regenerative agriculture is a holistic, systems approach to farming and the food system that results in improved ecological, social, and economic conditions, including:

- Producing abundant, healthy food
- Enhancing soil health and soil biological life
- Supporting functioning ecosystems where wildlife thrives
- Supporting thriving rural communities
- Creating opportunities for people of all backgrounds, but, particularly black, indigenous, and people of color

American Farmland Trust, 2022

These plans are developed by teams of farmers and other consultants who suggest options for increasing income through improved management practices, diversification, value-added initiatives, and other strategies. The team also makes recommendations regarding environmental and resource conservation concerns. Participants in the program may be offered grant funding to implement recommendations identified during the process in exchange for agreeing to a temporary (usually five- or ten-year) agricultural covenant on the property. Applicants must meet certain criteria for acreage, farm income, and other parameters, which could be screened through the Agriculture Commission. Farmers and landowners who do not meet the requirements for or do not wish to participate in an FVEP evaluation should still be encouraged to discuss options for best practices with the Commission, which has extensive knowledge and resources regarding climate-smart and regenerative farming practices. Particular priorities should include the preservation and enhancement of riparian buffers (as discussed in Section 3) and pollinator habitat.

Climate Smart Agriculture Program

Project Examples:

Diversification to perennial crops
Installation of hoop houses/high tunnels
Structures for pasture shading
Irrigation upgrades
Conservation tillage equipment
Fencing for rotational grazing
Silvopasture development
High efficiency maple sugar evaporators
Photovoltaics with battery storage
Wind systems
Solar thermal technologies
High efficiency wood biomass heating systems

Use the Agricultural Commission to connect farmers with other potential sources of funding through the Massachusetts Department of Agricultural Resources.

MDAR offers various grants and loans for agricultural projects in addition to FVEP. One option that may be attractive in Plainfield is the Climate Smart Agriculture program, which encompasses several grant programs designed to aid farmers wanting to implement climate resilience projects. These include the Agricultural Climate Resiliency & Efficiencies (ACRE) grant, the Agricultural Environmental Enhancement Program (AEEP), and the Traditional Ag-Energy Program (ENER) grant. The combined programs provide incentives for applicants to address vulnerabilities associated with climate change, adopt practices that mitigate contributions to climate change, and implement energy efficiency and renewable energy projects on farms.

Dual-Use Solar

Dual-use solar, also known as agrisolar or agrivoltaics, is the practice of co-locating solar photovoltaic panels on farmland in such a manner that primary agricultural activities including animal grazing, crop or vegetable production can continue simultaneously on that farmland (AFT, 2020).

Can it be done in New England?

Currently, the largest dual-use project in the country is a 10-acre, 4.2-megawatt system installed in the summer of 2021 on a blueberry farm in Rockport, Maine. Researchers from the University of Maine Cooperative Extension are evaluating the impacts of panel installation methods on the blueberry plants and will monitor crop conditions over time (USDA).
Read about other example systems, including one at the UMass Amherst Research Farm in South Deerfield, in the Appendix.

Preserve and Enhance Plainfield's Agricultural Capacity

In addition to the strategies in the Smart Growth / Smart Energy Toolkit, other actions recommended to preserve Plainfield's agricultural lands and activities include the following:

Prioritize preservation of remaining unprotected prime/important farmland for agricultural use; consider allowing provisions in APRs or other conservation easements that allow for appropriate new technologies, such as qualified agrisolar systems.

The American Farmland Trust recently completed a two-year collaborative study on smart solar siting policies and programs in New England, acknowledging issues such as competition for land and potential impacts on communities and natural resources. Their guidance suggests a range of flexible policy approaches designed to maintain active and productive agricultural land

while also supporting solar energy, particularly by using dual-use (agrisolar/agrivoltaic) systems. In Massachusetts, these systems are supported through the Solar Massachusetts Renewable Target (SMART) program, which provides financial incentives to qualifying systems. One of the primary requirements is that the system be located on land either "in agricultural use" (i.e., as defined by Chapter 61A) or classified as "important agricultural farmland" (i.e., prime farmland or farmland of statewide importance as defined by the NRCS). Agrisolar systems that are designed for minimal interference with crops or livestock and low-impact installation/decommission (e.g., driven post foundations) can therefore be a mechanism for maintaining important farmland in agricultural use for the lifetime of the system while deriving additional income and energy resilience benefits.

Advocate for state incentives and investments in climate-friendly farming solutions.

Enhanced support through federal- and/or state-level funding and policy will be needed to realize many climate adaptation and mitigation measures in small rural towns like Plainfield. Town officials, committee members, and resident activists can create political pressure by lobbying for policy development around climate solutions such as payments for ecosystem services and programs that support farmers adopting regenerative practices. Such actions may be more impactful as a coordinated effort between Plainfield and its neighboring communities, many of which have similar characteristics and challenges, and could prompt support in the form of a regional initiative.

Use the Agricultural Commission as a "clearinghouse" to help connect current and prospective farmers with land, housing, information, and other resources and develop farming succession plans.

Stakeholders noted several socioeconomic barriers and challenges facing farms in Plainfield, including farmers nearing retirement, inability of new farmers to find land or affordable housing, and absentee landowners without strong community ties. The Commission can serve as a resource to individuals evaluating their options. For example, the bylaw allowing accessory apartments may increase housing opportunities for farm workers or lessees, although the special permit requirement is still quite restrictive. The Commission should also participate in future advocacy efforts (related to the previous recommendation) around garnering state-level support and funding programs for young or beginning farmers to gain secure access to land. This should include support for tribal communities seeking greater land sovereignty.

Consider strategic conversion of reforested prime farmland to pasture or cropland.

Climate change impacts may mean Plainfield should consider balancing the carbon mitigation potential of its forests with its capacity to produce food locally. As previously discussed, much of Plainfield's currently forested land was previously cultivated or used for pasture, but only a relatively small portion consists of potentially highly productive soils. Reclaiming these areas for agricultural (non-forestry) use could supplement Plainfield's food production capacity and using regenerative farming practices (as suggested by the USEPA and AFT) would help offset increases in GHG emissions or loss of sequestration potential due to clearing. Alternatively, exploring the use of agroforestry

Common Types of Agroforestry Systems

Silvopasture combines trees or forage and livestock. Animals benefit from shade and their manure fertilizes the plants.

Alley cropping uses trees arranged in rows with crops placed in the "alleys" between the rows. Hay or grazing animals can also be integrated into the alleys.

Forest gardens integrate food, herbs, timber, and non-timber forest products like mushrooms in the same area, providing farmers with diverse income.

Trees and shrubs can be integrated into **riparian buffers** that simultaneously provide edible or other marketable products, protect riverbanks, and provide wildlife habitat.

Windbreaks and **hedgerows** used to protect crops can also create pollinator habitat and reduce soil erosion from wind, as well as provide yields themselves.

and/or perennial food systems such as fruit or nut trees could be strategies to gain food yields and maintain the climate change benefits of tree cover simultaneously. Further research is needed to evaluate current carbon storage and future carbon sequestration potential of various land use scenarios to make the best choices on this front. In addition, Plainfield should consider its forests and farms in the larger regional context and the role they might play in a collaborative scenario such as those proposed in *A New England Food Vision* to determine their preferred land use.

Promote Small-Scale Local Food Production

Organize and host community education sessions on home food production, preservation, and storage; support small-scale food production in community gardens and residential plots.

There is an opportunity to promote local food production in Plainfield using approaches other than large-scale agriculture. Plainfield should look for other locations in town that could be suitable to establish additional community garden spaces. In addition, as shown in Map 4-1, there are many residences near the town center that lie on potentially productive soils that could support garden plots for individual homeowners or small neighborhood groups. The Agricultural Commission or other town bodies could work to provide educational materials, speakers, and events that could increase interest and participation in home food production and enable residents to be better prepared in the event of extended power outages or other disruptions to food supply.

Pursue a regional collaboration or study regarding community food systems; contact Hilltown CDC as a potential partner.

While the scope of *A New England Food Vision* encompasses multiple states, there may be opportunities to build smaller-scale collaborative systems that would improve food security for Plainfield and neighboring communities facing similar challenges. Models for shared systems and resources already exist among the hill towns, such as for emergency services. In nearby Chesterfield, the Hilltown CDC is a community development organization serving the hill town region. Among other activities, Hilltown CDC runs an initiative in partnership with two other county-level organizations (Healthy Hampshire and Community Involved in Sustaining Agriculture) in which they recently created an action plan regarding the development of an alternative food distribution pilot program. The program also seeks to provide technical assistance to local farmers, advocacy and initiatives to expand local food markets, and mechanisms to increase access to local food. Progress on this initiative is ongoing and extremely relevant to both the future of farming and the composition of the food system in Plainfield.

Chapter 5

Energy Systems

"If we're gonna have mega storms like the climate scientists predict, we better be planning for maybe not having electricity."

- Plainfield resident

SECTION SUMMARY

The availability, reliability, and source of energy is a major component of community resilience in Plainfield. Outages as a result of severe weather events can leave residents stranded without power, heat, or water. In addition, residents acknowledge that burning fossil fuels contributes to climate change, and stakeholders expressed a general desire to reduce dependence on fossil-based energy sources.

High-voltage electrical transmission line in Plainfield

Some residents have installed solar photovoltaic (PV) systems at their homes and there is one large-scale solar array near the center of town. While these systems reduce the overall use of fossil fuel-based energy in town, they are tied to the grid and therefore still vulnerable to outages. It is hoped that further developments and price reductions in battery systems will enable the storage capacity to provide backup power in case of outages. The Plainfield Energy Committee has been very active in promoting residential solar and successfully gained a Green Communities designation for the town, making it eligible for grant funding. Challenges in locating suitable sites and limitations on the types of project that these funds may be used for have prevented the Committee from being able to install solar PV systems on municipal buildings. Instead, the grant funds will be put toward energy efficiency and decarbonization measures.

It is presently unclear what role additional large-scale solar arrays will play in Plainfield's energy future. There are very few open spaces in town that are not already developed or being used for agriculture, and residents are concerned about deforestation and other potential environmental impacts associated with solar fields. The Town has the authority to regulate large-scale solar through zoning bylaws, which can be amended to include desired measures or restrictions to protect valuable natural resources. Dual-use solar (agrisolar) may be one potential means to combine some solar PV with active agricultural use on the same piece of land.

This chapter describes the primary energy systems that power Plainfield, the current status of renewable systems and considerations for expansion, and some of the challenges and vulnerabilities related to climate change that affect energy resilience in town. A list of recommended strategies and actions regarding planning, increasing energy efficiency and reducing demand, and reducing the vulnerability of the current system is provided beginning on Page 76.

Powering Plainfield

Community members involved in stakeholder calls held in February 2022 indicated that Plainfield residents rely on a mix of energy sources for power and heating, including grid electricity, fossil fuels, wood, and solar photovoltaic (PV) panels. Grid electricity in Plainfield flows from a substation linked to a high-voltage transmission line bisecting the town and is distributed throughout town using aboveground lines, which generally follow established roads and occasionally cut through open fields. Electrical utilities and infrastructure are managed by Eversource. The transmission line feeding Plainfield runs between Pittsfield and Greenfield and appears to be sourced from the Cabot Generating Station, a 62-megawatt hydropower project located on the Connecticut River between Turners Falls and Montague (Figure 5-1). It is unclear whether all the electricity supplied to the transmission line is generated by this facility. As a region, New England derives its electricity from a variety of sources including fossil fuels, natural gas, renewables, and imports (via interconnections with Quebec, New Brunswick, and New York) (Figure 5-2).

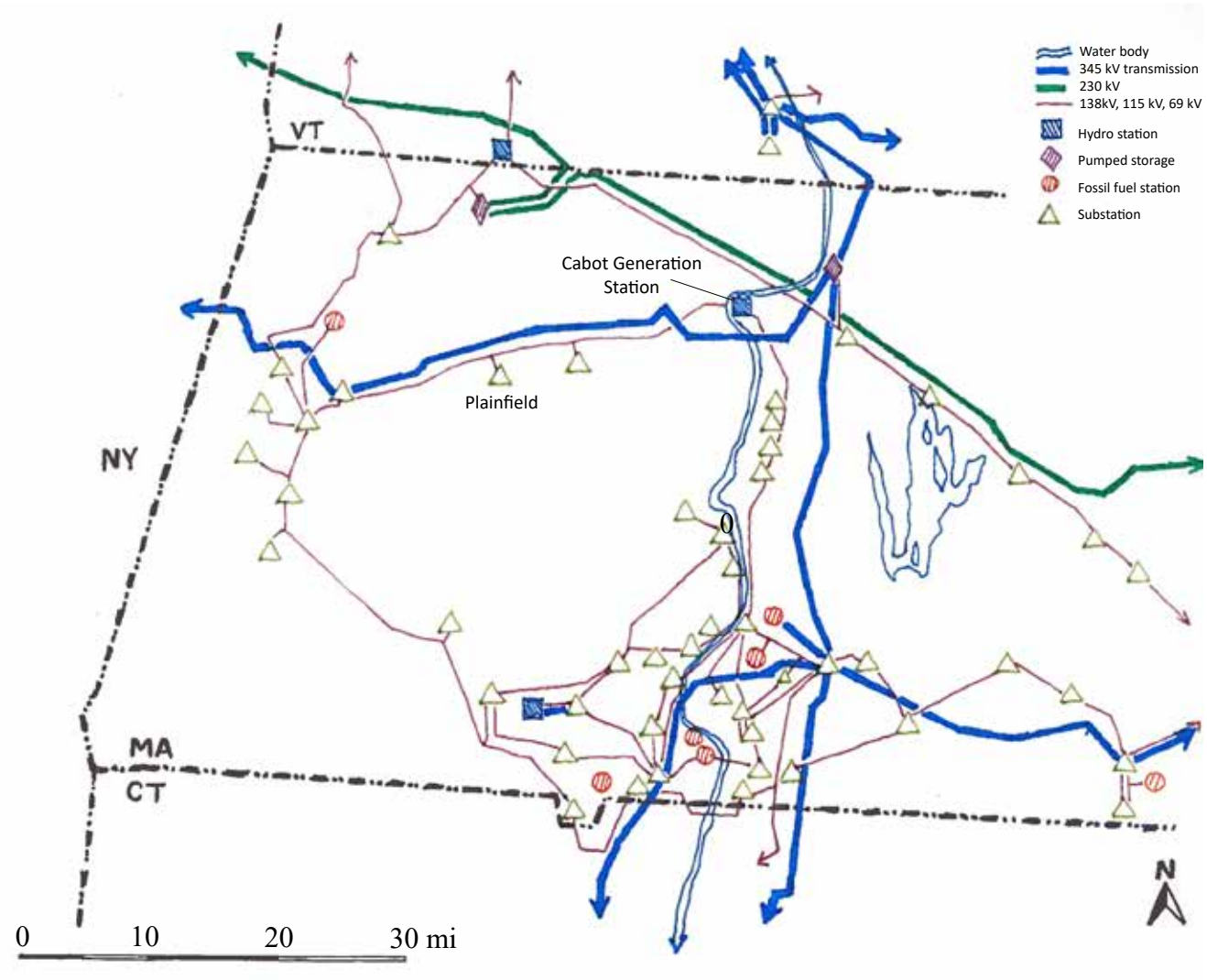


Figure 5-1. Western Massachusetts Geographic Transmission Map
Shows existing electrical generation and transmission infrastructure in the western Massachusetts supply network (adapted from ISO New England).

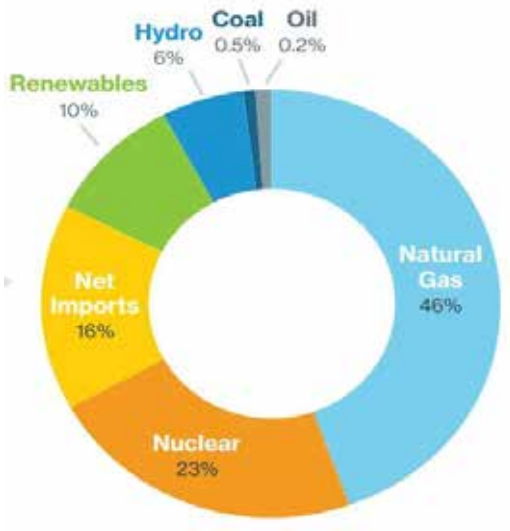


Figure 5-2. Breakdown of New England electrical energy sources, 2021 (ISO-NE.com)

Renewable Energy

ISO New England, which is responsible for the operation of electric power generation and transmission systems and oversees regional electricity markets and planning in New England, has tracked a steady reduction in carbon emissions as the regional grid transitions to more and more clean and renewable energy sources, with wind, solar, and battery storage projects dominating new proposals (ISO-NE, 2022). All six New England states have some sort of renewable energy standard requiring electricity suppliers to provide customers with increasing percentages of renewable energy. Five states, including Massachusetts, have also set specific goals for reducing GHG emissions. ISO New England forecasts particularly strong growth in solar PV in Massachusetts because of these initiatives (ISO-NE, 2022) (Figure 5-3).

Figure 5-3. Forecasted growth of solar PV capacity in New England

Values in megawatts of rated nameplate capacity (ISO-NE.com)

In the Commonwealth of Massachusetts, local governments have siting authority over all proposed solar arrays of less than 100 megawatts in capacity via a solar bylaw. The Pioneer Valley Planning Commission has created a guidance document including model bylaw language to aid communities in creating their own solar bylaws. This guidance includes general recommendations on siting, environmental standards, construction, maintenance, decommission, and financial strategies. Plainfield's existing solar bylaw includes most of the basic prescriptions included in this model for large scale ground-mounted solar photovoltaic installations, which they define as having a rated nameplate capacity of greater than 50 kilowatts. There is currently one such array installed on private property between Union Street and Main Street. Large arrays are constructed by private developers and add more renewable energy to the grid while providing revenue to the town (typically through tax and/or surcharges). There is currently no wind power infrastructure in Plainfield, although there is a single large turbine at the Berkshire East Ski Resort in nearby Charlemont as well as several much larger installations in the Berkshires to the west.

Nexamp solar array, Plainfield, MA

Plainfield has an active Energy Committee with a strong interest in renewables, particularly solar PV. Many of the current residential solar systems were installed as a direct result of the Committee's advocacy of the Solarize Mass program in 2015. The program, a partnership between the Massachusetts Clean Energy Center (CEC) and the Massachusetts Department of Energy Resources (DOER), sought to encourage the adoption of small-scale solar electricity by offering a bulk purchasing program wherein communities could

aggregate their buying power to obtain lower installation prices and subsequent power rates. The Energy Committee reported that over the course of a year, Plainfield increased the number of residences with solar PV units from six to more than thirty through participation in this program. It is believed that essentially all these systems are tied to the grid, with residents receiving credits based on a net-metering agreement with the utility. Comments made by residents during several stakeholder meetings held in February 2022 indicated that people were happy with their systems and several more households are planning to install rooftop or ground solar even though the Solarize Mass program is no longer active.

The Massachusetts DOER is now guiding municipalities towards creating their own clean energy adoption programs or participating in the Commonwealth's Green Communities (GC) competitive grant program, which provides funding and support for clean energy and energy efficiency projects in municipal buildings, facilities, and schools (MA DOER, 2022). In 2016, Plainfield applied for designation as a Green Community and was awarded grant funds of approximately $138,000 for energy projects in town. Under the terms of the grant, Plainfield established a solar overlay district and set a goal to reduce the Town's energy use by 20%. Designated Green Communities are expected to demonstrate energy leadership by tracking their energy usage, establishing fuel-efficient vehicle policies, encouraging energy efficiency in new construction, and implementing energy efficiency measures, and must submit an annual report detailing their progress and activities. Competitive grants are offered annually to all active Green Communities as long as funds are available and the community has used up all previously awarded funds.

To date, Plainfield has used some of the 2016 grant to install high-efficiency LED lightbulbs in the three primary Town buildings (Town Hall, Hallock Building, and Public Safety Complex) and has been working to identify other measures that may be approved under the GC program. According to the Energy Committee, initial plans to add insulation to the highway garage were discarded due to structural concerns. The Committee wished to use the remaining funds to support solar PV since it will not be eligible under future GC grants, but the Town has struggled to find suitable sites since there are very few Town-owned properties and many were deemed unsuitable for solar by the Committee for a variety of reasons (unfavorable orientation, risk of falling ice and snow in winter, etc.). The pavilion behind the Hallock Building and part of the roof of Hathaway Hall have been identified as two candidate locations; however, the Committee reports that further discussions with administrators of the GC program at DOER have ruled that the Town must have additional energy conservation measures in place before they can install solar. Therefore, the Town has agreed to install high-efficiency air-sourced heat pumps for heating and cooling in municipal buildings, but since future GC grants cannot be used on solar, it is highly unlikely that there will be sufficient funding left over from the current grant or given in future to pursue additional solar PV units on Town properties. However, other funding opportunities through state or federal programs may be available.

Energy Efficiency

Although the Plainfield Energy Committee was disappointed by the difficulties they have encountered in trying to implement a solar project for Town buildings, reducing energy consumption through reduced demand and increased efficiency is a worthy and achievable goal. Reduced energy needs translate directly to reduced costs, as well as reduced climate impacts from fossil fuel emissions (or obviate the need to build potentially costly renewable systems). Many of the homes and buildings in Plainfield are over fifty years old—

some significantly older—and were built without adequate insulation or energy-efficient windows, doors, and appliances. In addition, buildings are often not placed to take advantage of existing site conditions such as solar exposure or wind protection that could help reduce energy needs passively. As a result, there is a significant opportunity to improve energy efficiency in both existing and new construction.

Challenges to Energy Resilience

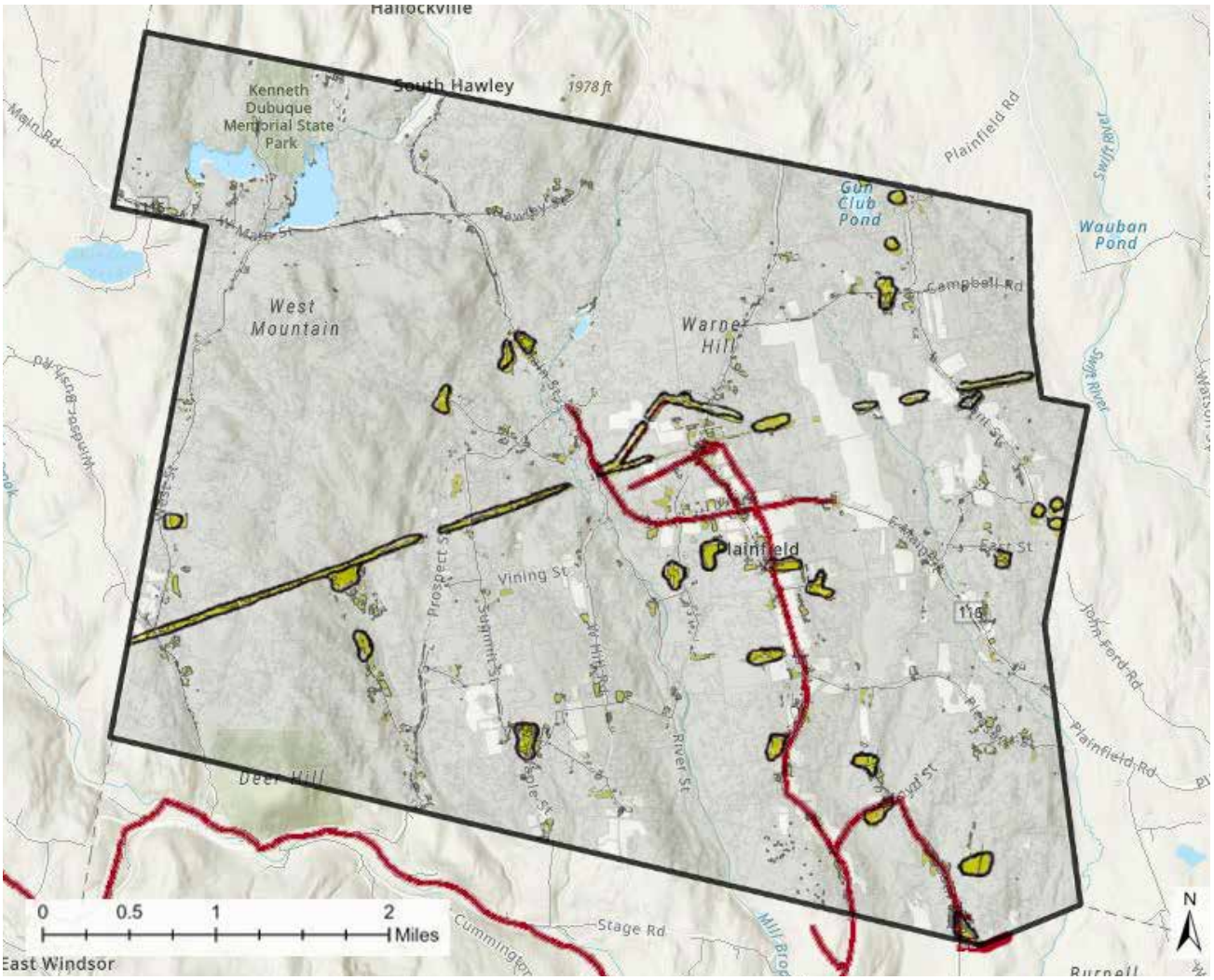
Power outages resulting from severe weather events were one of the primary hazards identified in the *Hazard Mitigation Plan* (2019) and *Municipal Vulnerability Preparedness Community Resiliency Building Workshop Summary of Findings* (2019). Plainfield's elevation increases the likelihood of experiencing snow or ice when lower neighboring communities might only receive rain, and its above-ground utility lines are vulnerable to high winds and snow and ice build-up during storm events. The many aging trees that line Plainfield's streets pose a particular risk of falling branches. According to stakeholder comments during outreach calls in February 2022, it is not uncommon to be without power for a day or more as utility crews struggle to repair lines. At best this is an inconvenience, but can be a significantly greater concern during winter due to loss of heat for many. Some residents may have special needs or are caring for elderly parents, and almost everyone in town faces the potential loss of access to water without functioning well pumps. While many residents have back-up generators, or can go to the Public Safety Complex (where there is also a diesel-powered generator), these systems are only functional as long as they have a fuel supply, and can be dangerous to both residents and utility crews if used incorrectly. The existing grid-tied solar PV systems around town also do not provide resilience against outages since they have no storage capacity; Energy Committee members present during February 2022 stakeholder calls did not believe that any of the systems incorporated battery storage.

Deteriorating street trees, such as this sugar maple, can be a danger to Plainfield's power lines

As previously discussed, many of the existing funding opportunities related to energy are focused on municipal properties and energy efficiency more so than renewable energy. As a result, the Town is somewhat handicapped since it has very limited property on which to install either efficiency measures or additional renewable capacity. Therefore, measures to significantly reduce energy usage and/or fossil fuel reliance town-wide would likely need to be implemented on private properties on a voluntary basis. An additional complication is the fact that because of the relative isolation of the town, most residents must commute long distances for work and supplies and are therefore reliant on automobiles. Transportation fuels thus represent a significant form of energy consumption in town, and one that is not straightforward to reduce.

Additional installation of large-scale solar has been proposed as a means to increase renewable energy usage in town. However, many concerns were voiced after the installation of the array in the center of town regarding environmental impacts. Although the existing town bylaw includes language regarding elements like tree clearing and stormwater management in general terms, stakeholders expressed worries over the use of land for solar rather than agriculture or preserving woodlands during stakeholder discussion calls held in February 2022. Most large areas of open land in Plainfield are already being used for agricultural purposes, leaving very few options for additional

large-scale solar that would not require clearing of forest (Map 5-1), and stakeholders stated concerns that existing protections may not be strong enough. They also cited concerns they had heard from other residents over the "industrial" appearance of the arrays and the impacts they may have on the visual character of the town. From a technological perspective, members of the Energy Committee stated that the existing capacity of the substation is not large enough to support a lot of additional power from new solar arrays, and any arrays that do go in must be located within a reasonable distance of appropriate transmission infrastructure to make connections cost-effective (Map 5-1).



Map 5-1. A Place For Solar?

The green patches on this map indicate areas that do not have forest cover and are not already being used for agricultural (i.e., cultivation or pasture/hay) in Plainfield, based on 2016 high-resolution aerial land cover analysis. These areas could be potential locations for large-scale solar arrays. To be cost-effective, arrays must be located near three-phase power. Existing three-phase power lines are shown in red.

SOLAR PANELS VS. TREES

In December 2015, 195 nations adopted the Paris Agreement, a landmark stand against climate change that sought to strengthen global mitigation efforts. The Agreement included a target for a global mean temperature rise of no more than 1.5 degrees Celsius over pre-industrial levels in order to prevent runaway climate change effects (UNFCCC, 2022). To accomplish this goal, global net carbon dioxide emissions must decline rapidly and permanently. This means simultaneously reducing emissions and increasing removal of carbon dioxide already in the atmosphere.

The Commonwealth of Massachusetts has set ambitious goals to reduce greenhouse gas emissions by at least 85% by 2050 and achieve net-zero emissions (EEA, 2020). Renewable energy systems, particularly solar photovoltaics, are expected to play a large role in emissions reduction strategies in the Commonwealth (Figure 5-3). Generating electricity from the sun eliminates the carbon dioxide that would have been produced by the equivalent combustion of fossil fuels: a clear win. However, critics claim that Massachusetts' energy policies are promoting the clearcutting of forests to make way for large, industrial solar projects (Save Massachusetts Forests), destroying one of the planet's best natural mechanisms for carbon control.

While the fact that trees and other plant species in forests absorb carbon dioxide for photosynthesis is nothing new, there has recently been increased research interest in understanding and quantifying the implications of this process for climate change mitigation. Forests—and wetlands—accumulate carbon and keep it out of the atmosphere while they remain undisturbed. **Proforestation** refers to a forest management approach that allows growing trees to reach their ecological potential for carbon storage in wood and soils (Moomaw et al., 2019), as opposed to strategies involving harvesting. Advocates see proforestation as an effective, implementable, and low-cost strategy to store carbon, and argue for preserving forest as forest wherever possible and particularly where older, larger trees already exist.

"Destroying forests to produce energy, even solar energy, just doesn't make sense when we consider their irreplaceable ability to sequester carbon and preserve biodiversity."

-Bill Stubblefield, Wendell State Forest Alliance

Energy proponents point to calculations showing that the carbon offsets provided by solar panels over their operating lifetime significantly outweigh the carbon absorption capacity of the typical number of trees growing on the equivalent area. However, they acknowledge that panels do not provide the valuable functions and services of a natural forest ecosystem, such as water filtration, soil stabilization, and wildlife habitat. In addition, some proforestation scientists claim that these carbon benefit calculations are flawed and do not take into account factors such as actual contributing area and low panel efficiencies (Moomaw, 2020). In addition, as far as carbon is concerned, the forest is more than the sum of its trees—a significant portion of the carbon in forest ecosystems is actually stored in soils and downed wood, not simply live trees.

Determining whether to allow the construction of large solar fields can be a complicated issue. Large solar companies can offer annual "payments in lieu of taxes" arrangements to municipalities that can be very hard for small, revenue-poor towns to refuse, although there has been some confusion and uncertainty over how well these arrangements actually work as well as which rules and incentives apply to which size and type of solar installation. There is a growing consensus that solar installation efforts should be concentrated first on existing unforested areas like rooftops, parking lots, and landfills, and conservation entities like Mass Audubon are calling for a moratorium on large-scale solar until the effects of state subsidies on land use can be further studied. Other municipalities are leveraging their authority through bylaw changes: the City of Northampton recently amended its solar ordinance to require a Special Permit and detailed impact assessment for any arrays requiring more than two acres of tree removal (City of Northampton, 2019).

RECOMMENDATIONS FOR RESILIENT ENERGY SYSTEMS

Reduced energy consumption and increased use of renewable energy sources offer an alternative to traditional overconsumption and reliance on fossil fuels, which contribute to pollution and whose supply can represent a national security risk. Both approaches contribute to increased climate resilience by reducing carbon emissions and making outages due to severe weather or other causes less impactful. These goals can be realized by concentrating on several different areas, including planning, the promotion of energy efficiency measures in buildings and transportation, and encouraging the development of renewables. Municipalities such as Plainfield can look to the *Massachusetts 2050 Decarbonization Roadmap* for guidance on strategies that are aligned with statewide energy goals.

Plan for Energy Efficiency and Decarbonization

Plainfield has already taken several important steps in pursuing energy goals, including the creation of an Energy Committee. The Committee has been very active in evaluating the condition and energy use of Town-owned resources and pursuing the implementation of small-scale solar PV systems on both residential and municipal properties. It is recommended that the Committee continue its activities and work with the Planning Board and other town committees to develop a cohesive strategy for long-term energy planning—particularly around the role and/or feasibility of large-scale solar in the future—through the following actions:

Continue Energy Committee activities around tracking energy use, emissions, and progress towards reduction targets for municipal buildings under the Green Communities program.

Green Communities must submit an annual report demonstrating that they continue to meet the designation criteria and include an update on progress made towards their 20% energy reduction goal.

The Plainfield Town Hall is slated to receive high-efficiency air source heat pumps through the Green Communities grant program.

Formalize a community-wide vision for energy conservation measures and generation from renewable sources as part of a Comprehensive Plan.

A Comprehensive Plan provides a vision for the community's desired identity or character, which guides development and other land use decisions. Because of the potential conflicts between large-scale solar and other important land covers such as forests or agricultural fields, it is important that the Town determine whether additional large commercial arrays are feasible and/or desirable in town. Focusing on energy efficiency and other decarbonization efforts can provide significant energy savings and climate mitigation benefits without the need for significant land area. The Energy Committee should work closely with the Planning Board and other Town committees to ensure energy considerations and goals are included in housing and economic development sections of the Comprehensive Plan as well.

Discuss status and options regarding substation capacity and interconnections with Eversource to establish feasibility limits for local renewables.

The existing substation in Plainfield does not have the capacity to support additional large-scale solar installations without an upgrade. Additionally, large-scale arrays must have access to three-phase power

to connect to the grid, which is only available along certain utility corridors in Plainfield (see Map 5-1). Understanding the technical and economic feasibility of pursuing the necessary upgrades as well as understanding the extent that renewables may already play in Plainfield's energy supply (i.e., hydropower and existing solar) may provide the town with some guidance on whether and/or how much large-scale solar capacity should be a part of the community's energy vision.

Consider supporting renewable energy by opting in to utility programs encouraging renewable energy certificates for energy use in municipal buildings.

The Massachusetts Renewable Energy Portfolio Standard requires electrical utilities to obtain a percentage of the electricity they provide from qualifying renewable energy facilities. Every 1 megawatt-hour of electricity generated by a renewable source is represented by a Renewable Energy Certificate (REC). Electricity consumers can sign up for a clean energy plan, in which a third-party company works with the utility to match the consumer's usage with RECs, thereby increasing the amount of renewably-sourced energy in the grid. Consumers can sign up as individuals through programs such as the Green Energy Consumer's Alliance "Green Powered." Alternatively, towns can offer municipal aggregation, where the community aggregates the total electrical load of the residents who choose to be involved and purchases electricity in bulk, thereby obtaining a discounted rate. Municipal aggregation programs must be prepared in consultation with the MA DOER and approved by vote. Once in place, the program can pursue a clean electricity contract to source all or part of demand from renewable sources. This may be an attractive alternative to reduce the community's carbon footprint without needing to construct large-scale renewable energy infrastructure in town, although it may be somewhat redundant if the majority of locally supplied power is already coming from renewable sources. In addition, the Nexamp array currently operating in town offers a community solar net metering credit opportunity through Eversource.

Build environmental protections into solar regulations.

While increasing the use of solar PV is an attractive option for improving Plainfield's climate resilience, there are many concerns in the community about the potential downsides of uncontrolled or poorly executed solar development, including forest loss and fragmentation, water quality impacts, and aesthetics (i.e., undesirable views from adjacent roads, homes, or properties). These concerns mainly apply to large-scale solar arrays installed on municipal land or private land by developers (rather than residential roof- or ground-mounted units). There is an opportunity to create more explicit guidelines in Plainfield's solar bylaw for the regulation of large-scale solar installations. For example, several municipalities in the neighboring Deerfield River watershed have adopted bylaws that identify suitable areas for installations while seeking to minimize potential negative impacts during all phases of the project (PVPC, 2020). Example measures include herbicide bans, stormwater management mandates, pollinator-friendly planting and management practices, array size limits, and prescriptions against using prime farmland.

There are different possible approaches to regulating solar development: one strategy is to treat it like any other type of development such that policies and siting processes do not create any restrictions that would not otherwise apply, while another strategy is to acknowledge the unique characteristics of solar arrays and draft specific guidance measures. It could be argued that the former approach might not include adequate environmental standards, while the latter could result in an overly restrictive policy that will discourage developers from applying. Given the uncertainties around both the positive and negative potential impacts of large-scale solar within town boundaries and the level of community concern for the environment, Plainfield should consider revising its existing solar bylaw to include more explicit protections for natural resources.

Keep abreast of federal, state, and regional funding and incentive programs related to municipal and residential energy; provide regular updates to residents.

Massachusetts residents and businesses have access to certain services and incentives to manage energy costs and use through the Department of Energy Resources and other programs such as Mass Save, which is sponsored by a group of local utility providers. Mass Save provides assistance with energy auditing,

equipment upgrades, rebates and incentives, and educational resources. Programs such as these are valuable tools for residents and businesses who wish to save money and reduce fossil fuel use, but where a renewable system may not be feasible or desirable.

Build With Energy Efficiency and Renewables in Mind

Buildings and transportation are major users of energy. Increasing the energy efficiency of homes, businesses, and municipal buildings saves money, reduces emissions, and decreases the impacts of disruptions in service. Plainfield can consider the following actions to achieve these benefits:

Take advantage of Green Communities grant funds to implement heating/cooling systems and energy retrofits in municipal buildings.

The Energy Committee should proceed with using its current GC funds to install energy measures in town buildings. Future applications could consider focusing on measures possible or necessary to promote decarbonization of municipal infrastructure and vehicle fleets, such as installation of electric vehicle (EV) charging stations. Planning for phased decarbonization should be implemented; for example, considering hybrid or EV purchase as fleet vehicles require replacement.

Require projects of a certain size or type to meet green building standards such as LEED, Energy Star, or net-zero. For smaller projects, consider options to incentivize green building and energy efficiency practices, such as expedited permitting.

Create and distribute educational materials detailing benefits of and strategies for ecological building and site design and high efficiency technology options for residential homes.

Residential energy efficiency can be improved using both active and passive means. Active technologies typically involve the use of high-efficiency appliances for HVAC, hot water heating, lighting, and other home systems. Passive approaches use ecological principles to reduce energy needs and environmental impacts of the building, resulting in both financial and environmental benefits. Examples of passive design approaches include orienting houses for solar gain, appropriate use of windows and overhangs, planting trees for windbreaks and shade, using hardy low-maintenance plants and materials in landscaping, and many more.

Design capacity for renewables into all renovations/upgrades for municipal properties.

Structural integrity and siting considerations greatly reduced the number of candidate locations for solar arrays on Town properties during the Energy Committee's recent evaluation. Future renovations or new construction should be planned with the ability to accommodate solar PV even if it is not immediately installed.

Decrease Vulnerability of Existing Energy Infrastructure

Continue working with Eversource to coordinate preventative tree maintenance activities. Educate residents about hazard trees and the responsibilities of the Tree Warden.

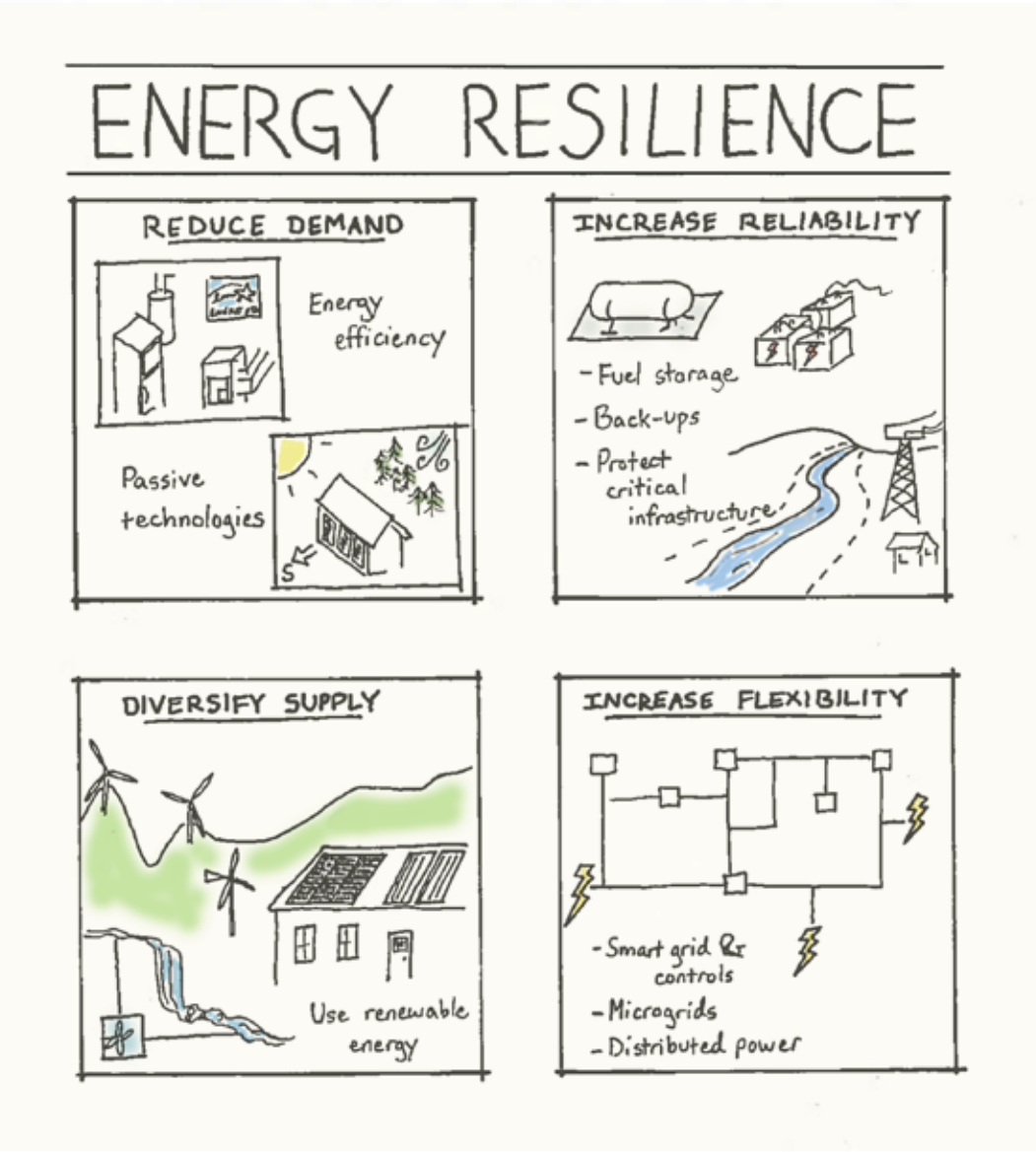
Many trees along Plainfield's roadways are in poor condition and pose a risk to power lines. Strategic trimming or complete removal of hazard trees can help reduce this risk. The Tree Warden in Plainfield is responsible for the care and control of all public shade trees, including cutting, trimming, or removal. Providing information and increased transparency on the rationale and due process for tree cutting and replacement activities should increase community understanding and decrease negative perceptions of these activities.

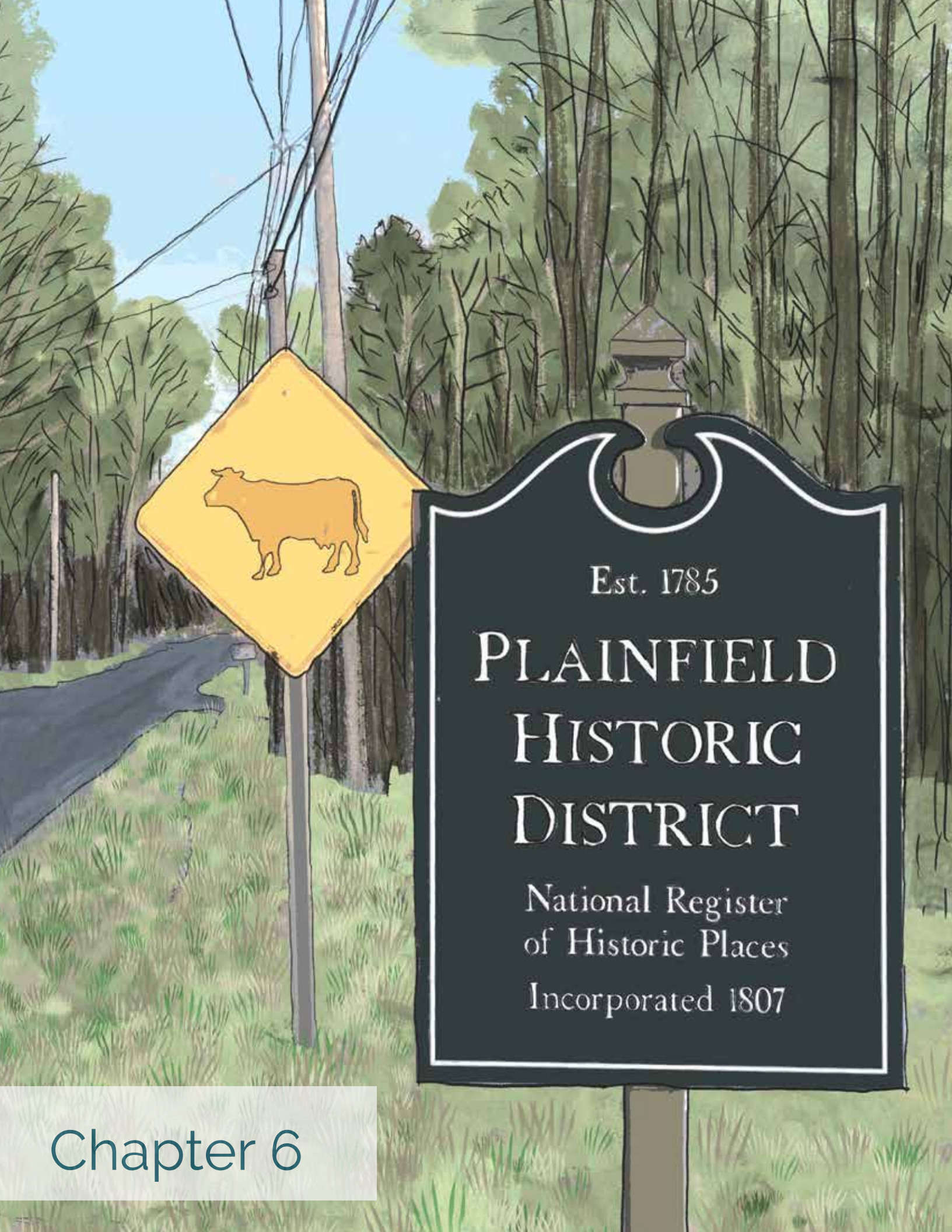
Bury electrical lines wherever possible.

Above-ground lines are vulnerable to damage from wind, snow, ice, falling branches, etc. during severe weather, which is predicted to become more frequent and more intense in the future due to climate change.

Consider battery back-up for any new municipal solar PV systems.

Battery back-up systems extend power availability during grid outages.

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PLAINFIELD
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DISTRICT
National Register
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Chapter 6

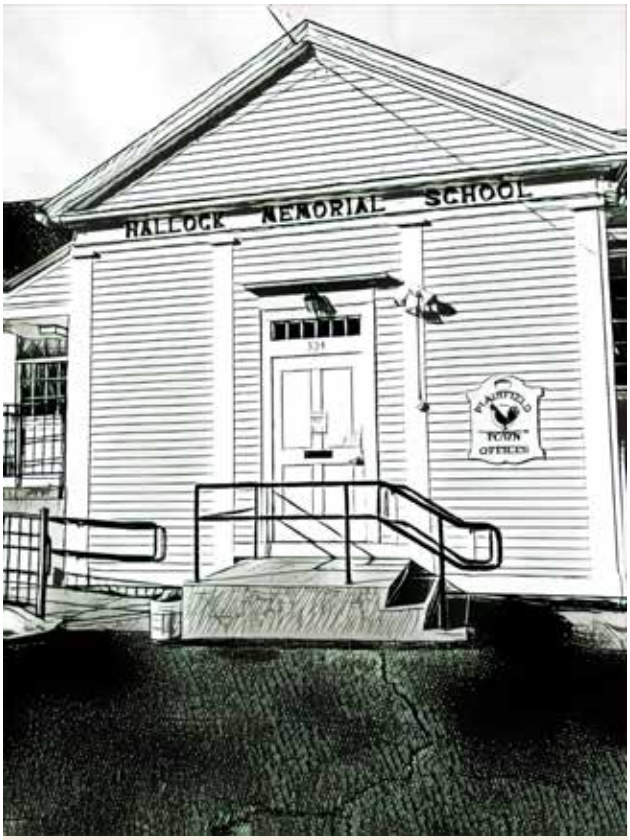
Community Infrastructure & Development

SECTION SUMMARY

Plainfield is currently zoned rural residential-agricultural and has a relatively large minimum lot size of three acres. This type of large-lot zoning is usually intended to maintain a feeling of rural open space, but can result in significant fragmentation of natural habitat as the number of structures built increases. As a result, residences are spread throughout town, resulting in a population that is physically isolated. In addition, due to a limited commercial base in town, residents are almost entirely dependent on cars to reach essential goods and services. Concerns have been raised over the generally aging population and likely future increase in demand for senior services as well as reliable emergency services access for vulnerable individuals.

Over the past thirty years, the town has not seen a large number of new housing starts, although there appears to be an increasing trend in recent years. As of 2020, high-speed broadband is now available in Plainfield, which has received high praise from residents and appears to be a significant factor in attracting new residents to the area based on anecdotal evidence. Residents have also reported increased activity in town real estate, believed to be a result of the COVID-19 pandemic prompting migration to rural areas.

This chapter provides an overview of Plainfield's social and built infrastructure and current zoning regulations. These regulations are used as the basis for a conceptual build-out analysis to evaluate possible future development in town, along with the potential implications for Plainfield's landscape. A list of recommendations regarding strategies and actions to control, guide, and build resilience into future development is provided beginning on Page 87.



The Hallock Memorial School—named for Reverend Moses Hallock, Plainfield's first ordained minister and educator—houses the Town Offices and library.

A Hilltown Community

Plainfield is a small, rural community characterized by extensive forest cover and sparse development—less than 4% of the town's land is developed for residential or commercial purposes. There is no defined town center; however, most civic and social activities take place in the municipal buildings and churches located on Route 116 near its intersections with Union Street and Central Street. There are few commercial businesses, mainly home-based ventures and suppliers of goods and services typical of a remote, rural town (e.g., auto repair, tire store).

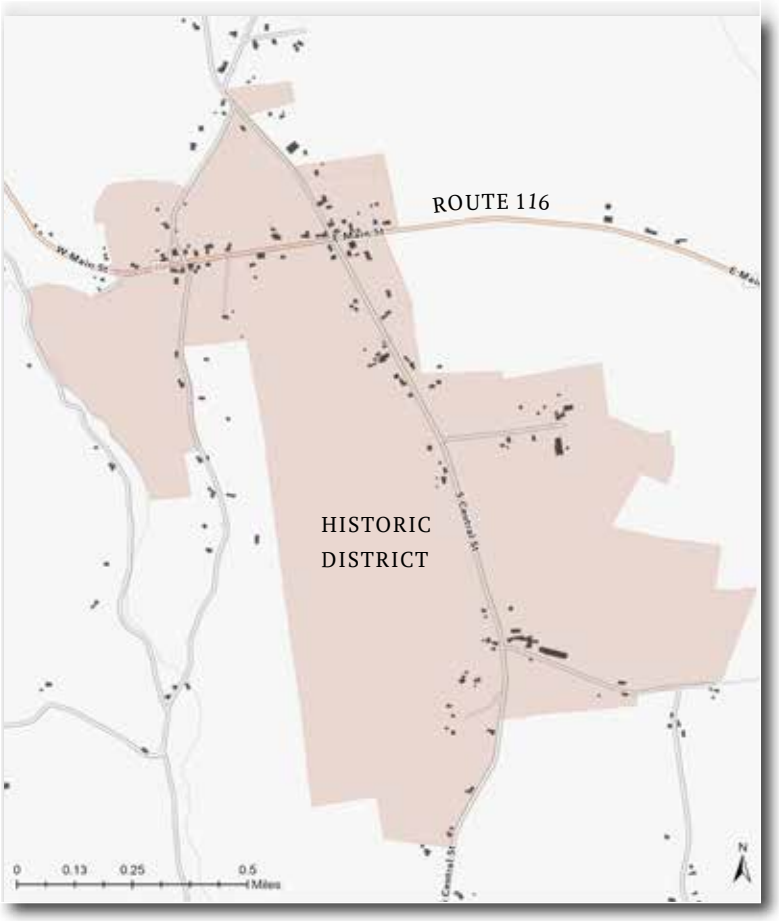
Rural residential patterns dominate in Plainfield, with homes, businesses, and farms distributed along roads—particularly Route 116, which is designated as a State Scenic Byway. The mixture of forested hillsides, ridges, rolling fields, and historic buildings along the 6.7-mile segment of Route 116 through Plainfield earned mainly "Distinctive" visual ratings in the *Route 116 Scenic Byway Corridor Management Plan* prepared by the Franklin Regional Council of Governments (FRCOG) in 2013. Many buildings in Plainfield date from the late eighteenth and early nineteenth centuries and exhibit characteristic architectural styles including Federal and Greek Revival. The Plainfield Historical Society completed an exhaustive inventory of historic buildings, houses, and landscapes and successfully applied for the creation of a Historic District, which was placed on the National Register of Historic Places in 2015. The most densely settled area of the District runs for approximately half a mile along Route 116 between Union and Central Streets, extending north to Hilltop Cemetery and south into more open farmsteads and pasture land, and includes 74 "contributing" structures and sites. While listing with the National Register is intended to recognize unique and culturally important resources and helps garner support for protecting historic sites, it does not place any restrictions on what private owners may do with their properties, up to and including demolition, unless federal or state funds are involved.

Shaw-Hudson House

Built in 1833 for Plainfield physician Samuel Shaw, the house now serves as a museum, offering a unique look into nineteenth century medical practice..

Did you know?

Municipal properties listed on the National Register are eligible to apply for grants from the Massachusetts Preservation Projects Fund.



Map 6-1. Plainfield Historic District

The Plainfield Historic District covers approximately 730 acres in the most densely settled part of town.

Zoning

Plainfield's zoning bylaw dictates which uses are permitted in which areas in town, the necessary approval processes, and numerous elements such as lot size, parking, signage, building heights, and setbacks. Under the current bylaw, which has been in effect since 1982, the entirety of the town is under a single Rural Residential – Agricultural zoning district, which generally permits residential and agricultural uses by right as well as a variety of business uses by Special Permit. In essentially all cases, new building plans in town are classified as "Approval Not Required," which allows building on lots with frontages on existing public ways without a formal review from the Planning Board, public hearing, or notification of abutters (as long as the lots meet all other dimensional regulations as given in Table 6-1). This is essentially a way to ease the approval of development projects that do not meet the formal definition of a subdivision and thus are not subject to Subdivision Control under Massachusetts General Law. There are currently no formal subdivision zoning regulations in place in Plainfield.

Mature sugar maples and stone walls are common sights along roadways in Plainfield and lend the town a strong sense of rural character.

Population and Development Trends

According to the most recent US Census Bureau data (2020), Plainfield has a population of 633, with a median age of fifty-two and an estimated 39% of residents over the age of sixty. These figures are significantly higher than the average for Hampshire County, indicating that Plainfield has an aging population relative to nearby municipalities. Eleven percent (11%) of Census respondents in Plainfield self-identified as having some type of disability. Almost 90% of Plainfield residents commute to work, driving an average of 39 minutes to reach other, larger municipal centers such as Greenfield, Pittsfield, and Northampton. Most of these commuters (80% of the working population) drive to work alone.

Plainfield currently has 335 housing units (US Census Bureau, 2020). In the last thirty years, Plainfield has not experienced a significant amount of new development; the town averaged less than three new building permits issued per year during this period and only about one per year between 2005 and 2015. However, the rate of development is showing signs of increasing: three new housing starts have been reported per year since 2015. In addition, during stakeholder calls held during February and March 2022, residents reported observing an uptick in newcomers and interest in town real estate in the last year or two. This is believed to be a result of the COVID-19 pandemic

Table 6-1. Plainfield Zoning District Dimensional/Density Regulations (minimum standards)

Lot Size, total or for first housing unit (ac)	Area for each additional housing unit (ac)	Lot frontage (ft)	Yard setbacks, front, side, rear (ft)
3	3	300	50

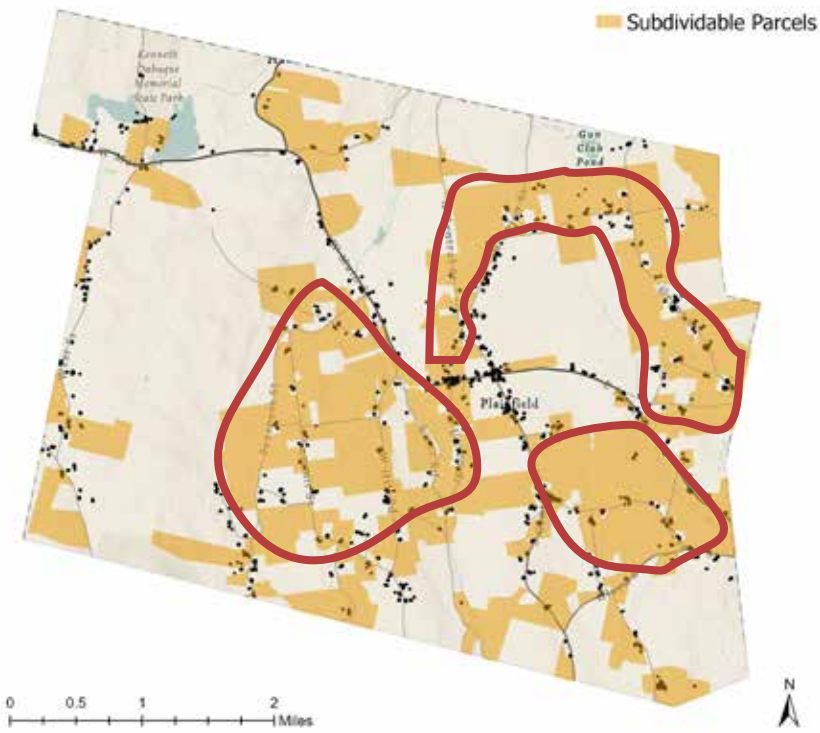
spurring an interest in rural living and the appeal of the broadband network recently installed in town.

Future Development Considerations

Build-Out Analyses

The Massachusetts Executive Office of Environmental Affairs (EOEA) produced build-out analyses for all Massachusetts towns in 2001 based on the maximum new development allowed by right under the zoning bylaws in each. Permanently conserved land was excluded, but Chapter 61 land was not, nor were environmental constraints such as steep slopes taken into account. This analysis indicated a total of 9,445 developable acres (or 3,765 potential housing units) in Plainfield. Another build-out estimate by the Pioneer Valley Planning Commission (PVPC) in 2003 estimated approximately 9,400 developable acres or 2,500 additional residential units. These build-out analyses are described in the *Plainfield Master Plan Land Use Chapter* written by the PVPC in 2013, which notes that without municipal water or sewer, increases in development of this scale seem unlikely.

As part of this Climate Resilience Plan, the project team repeated a preliminary build-out analysis exercise based on the regulations for minimum frontage and lot size given in Table 6-1, which have not changed since the previous two analyses were done. First, the analysis identified all parcel frontages greater than 600 feet in length (i.e., able to be subdivided into at least two lots), on both sides of existing public roads. Parcels under permanent conservation easements were removed. Then, parcels with areas of at least 6 acres were isolated from within this subset to represent lots that could be subdivided and still meet both the frontage and acreage criteria. The results indicate at least three general areas in the eastern half of town where significant subdivision and development could theoretically take place, adding up to approximately 4,650 acres or just over a third of the town (Map 6-2). The total number of potential new lots created was determined by calculating the lesser of the new lots "allowed" by frontage vs. acreage requirements for each parcel identified. For example, a 30-acre lot with 1,000 feet of frontage could theoretically be subdivided into ten 3-acre lots, but only three parcels with at least 300 feet of frontage, so the total number of possible new lots would be taken as three. Summing these across the dataset resulted in a total of 561 potential new lots/housing units.



Map 6-2. Potentially Developable Areas

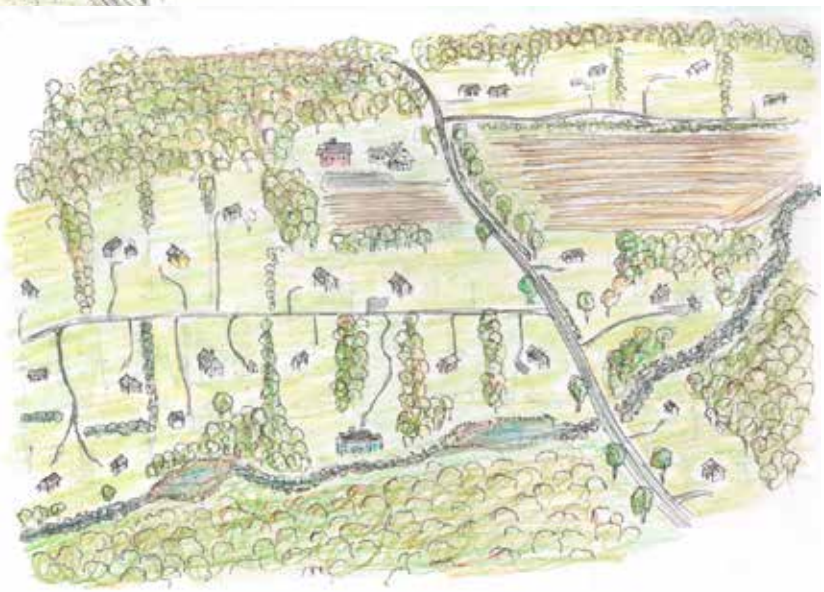
Based on the current zoning regulations in Plainfield, there are three major areas of town where significant subdivision and additional development could take place (outlined in red)..

While there are some inaccuracies in this analysis (for example, the frontages of some parcels that apparently meet length requirements are not actually continuous), it seems to provide a more plausible result than the previous evaluations. Actual feasible development is almost certainly lower due to environmental and/or systems constraints like steep terrain, drainage concerns, water supply, or utility capacity; alternatively, development potential could increase significantly with the construction of any new roads that would provide additional frontage. Regardless, the implication is that the current large-lot zoning regulations and ease of the ANR process potentially allow a level of highly distributed development that could significantly change the

visual character of the town. In addition, widespread clearing of lots and subdivision of parcels for new homes could lead to habitat fragmentation and loss of important forest and agricultural lands, as well as potential impacts to sensitive aquatic resources.

Climate Change Implications

Climate change also has implications for development in Plainfield. With rising sea levels, increased temperatures, and increased risk of flooding in low-lying areas from severe precipitation events, there will be pressure on global populations to move to higher elevations with more temperate climates and relatively secure water resources. In the United States, New England represents one of those areas, particularly elevated inland areas like Plainfield. However, these characteristics certainly do not make Plainfield immune to climate effects, as the string of recent weather events described in Chapter 1 shows, nor are all parts of Plainfield equally affected. Without a major river, Plainfield is not classified as a floodplain community, but it does have relatively low-lying areas along its streams where development could simultaneously contribute to and be threatened by periodic flooding, as described in Chapter 3. On the one hand, the effects of severe weather and other hazards can be particularly impactful in Plainfield due to its isolated position in the region, the spatial distribution of its population, and high likelihood of disrupted access and communications, so denser development could actually help create stronger and more reliable social and physical connections between residents and critical supplies and services. On the other hand, development has the potential to exacerbate some climate change effects through loss of carbon storage and sequestration capacity and increased stormwater runoff volume and contamination from impervious surfaces.



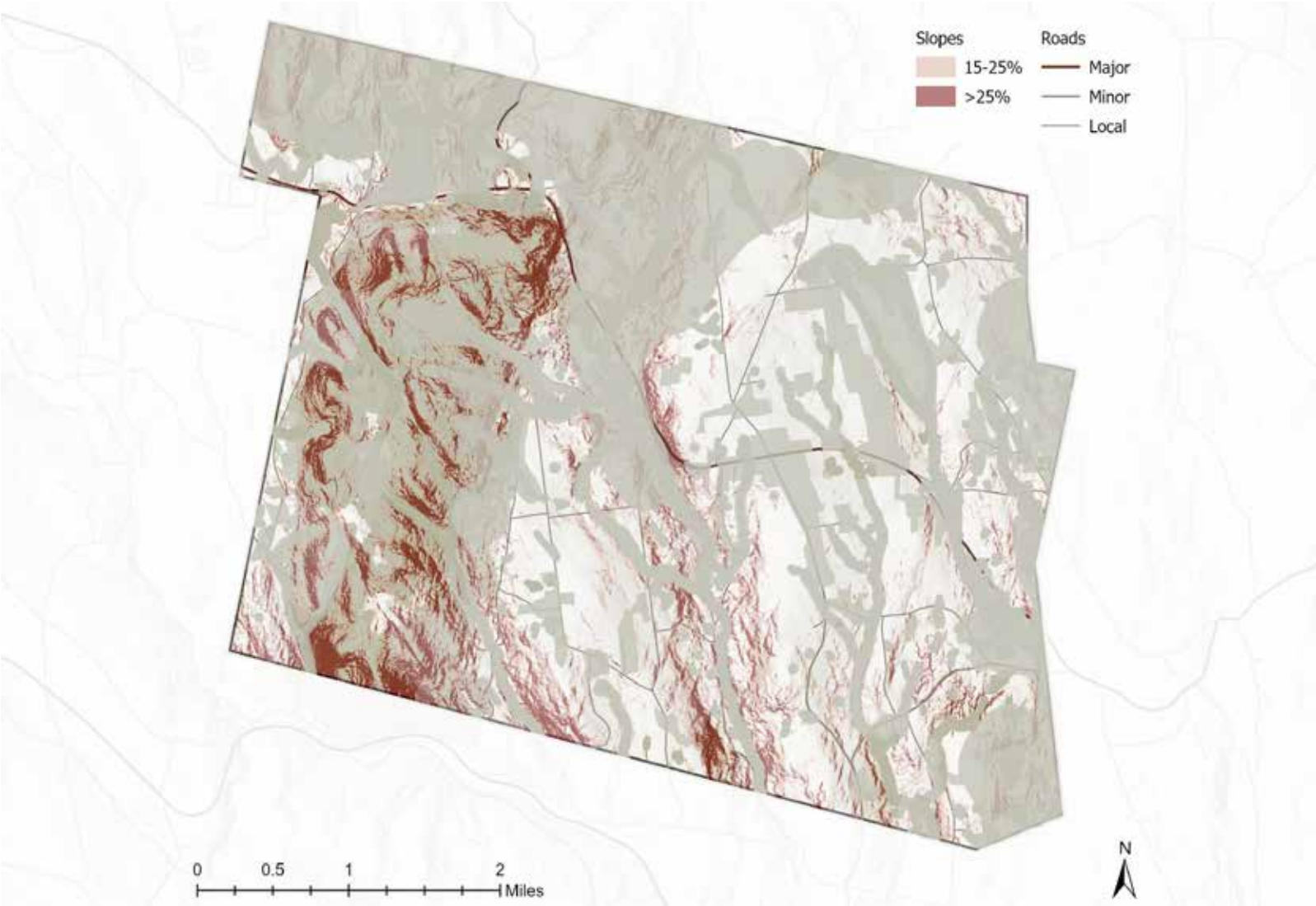
Conceptual Landscapes

These sketches show how a theoretical landscape in Plainfield might look in the future (right) versus today (above) under the current zoning regulations.

Where (Not) to Develop?

These are complex issues with no easy answers; however, the analyses described in this Plan suggest that development in Plainfield should be carefully guided and controlled. The previous sections of this Plan have discussed the climate resilience benefits that intact natural resources and ecosystems provide and pointed out particularly sensitive or important areas to protect. Taken together, a vision of the Plainfield landscape can be created that highlights areas where development should be avoided (Map 6-3). By extension, the areas left over are suggested as potential "lower-impact" candidates for thoughtful growth, with the understanding that it is not practical to avoid all development impact everywhere.

Within these areas, clustering development may be a strategy to limit environmental impacts even further, thereby preserving Plainfield's rural character. This approach to development also has potential implications for social and community resilience in the face of climate change by facilitating communications and emergency access, encouraging social interaction, creating appropriate spaces to support commercial and service enterprises, and reducing the vulnerabilities of isolation for elderly or otherwise at-risk individuals.



Map 6-3. Areas to Avoid Development

Areas identified by the analyses in this Plan as particularly sensitive or otherwise of high preservation value are shown in gray. These include the following: contiguous forest and unique patch habitats in the western portion of town; water resource buffer areas; existing permanently protected areas; important farmland. It is recommended to avoid all development in these areas if possible. Construction activity is difficult and can have negative environmental consequences on slopes greater than 15% and should be pursued with caution. Development activity on slopes greater than 25% is not recommended.

Plan for Smart Growth

The town's primary tool for guiding future development lies in zoning and bylaw changes. This Plan acknowledges that the creation and/or amendment of such policies can be a lengthy and often contentious process and may need to be revisited multiple times before an acceptable decision can be reached by the community. Fortunately, Plainfield appears to be in a position of recognizing the opportunity for increasing climate resilience through land use decisions and being able to act well before the town comes under significant pressure from development.

As part of planning for the possibility of increased demand for housing and services in the future, Plainfield should consider how best to guide commercial and residential growth in a manner that minimizes impact on natural resources and community character.

Update and expand the existing Plainfield Master Plan to include broader evaluations of socioeconomic elements.

A master or comprehensive Plan is a dynamic long-term planning document that provides guidance on future growth and development by laying out a vision for the community's desired identity or character. Comprehensive Plans can include analyses, recommendations, and proposals on a wide range of community elements, such as population, economy, housing, community facilities, energy systems, and land use, and can consist of multiple chapters or separate documents addressing each area. In Plainfield, a community development plan called the *Plainfield Vision & Action Plan* was created in 2003 by an outside consultant (LandUse Inc.), which evaluated the town's land use at the time and provided some recommendations for public and private land use distribution in the future. This was followed by the *Plainfield Master Plan Land Use Chapter* in 2013, which was developed by the PVPC in partnership with the Plainfield Planning Board and Board of Selectmen. Although the title of this document suggests it was intended as a chapter of a (presumably) larger Master Plan, no additional recommendations or chapters have been developed since.

One of the elements of the *Land Use Chapter* was an acknowledgment of the tradeoffs between preserving the existing character of the town and attracting a larger commercial/industrial tax base to help increase town revenue and support the provision of town services. Land use is inextricably tied to social, economic, and environmental concerns. Therefore, it is recommended that Plainfield update and expand the 2013 evaluation into a Comprehensive Plan, which should provide an overarching vision for the town to ensure that the results of land use decisions are aligned with community needs and desires. Typically, an update to a Comprehensive Plan also warrants a zoning update to ensure that the land use vision outlined in the Plan is put into law.

Open Space Design / Natural Resource Protection Zoning

OSRD/NRPZ (or OSRD) is an innovative form of subdivision design that maximizes resource protection while providing economic profit. It includes elements of conservation subdivision regulations and cluster development bylaws which help mitigate sprawl impacts by addressing both open space/ natural resource preservation and construction of housing.

Precedents

Caldwell Farm, Newbury, MA

Statistics: 125 acres, 66 units, 100 acres conserved, ca. 1800 farmhouse preserved
Project highlights: OSRD approved through Special Permit; 50% minimum open space conservation; density bonuses provided for historic preservation, affordable housing, and protection of additional open space; developer installed a shared wastewater treatment plant

Partridgeberry Place, Ipswich, MA

Statistics: 40 acres, 20 units, 28 acres conserved
Project highlights: compact OSRD site design; minimum land disturbance; extensive LID practices (rain gardens, grass swale and bioretention, reduced lawn, native landscaping, roof runoff infiltration); shared septic system

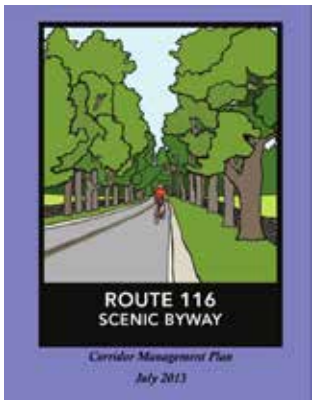
Mass.gov

Revisit Open Space Design/Natural Resource Protection Zoning as an alternative to Approval-Not-Required.

There are several potential options for Plainfield to utilize zoning decisions to help guide development in a way that protects valuable natural resources and promotes climate resilience. One of the most promising approaches is the use of Open Space Design/Natural Resource Protection Zoning (OSD/NRPZ), which concentrates development on a portion of a site and preserves the rest for conservation, recreation, or other non-developed uses. This approach is particularly effective in rural areas with low underlying development density like Plainfield since it results in meaningful amounts of land set aside for protection. A version of this technique was proposed in the 2013 *Land Use Chapter* as having the potential to preserve rural character along roadways by allowing development further back on lots and maintaining vegetative buffers and wildlife corridors. A stakeholder commented during a community outreach presentation held in March 2022 that he recalled a similar measure being proposed "a while back" that was unsuccessful. Nevertheless, analyses suggest that this approach would be much more effective at reducing fragmentation of important woodlands and open spaces than the equivalent amount of development under the current large-lot zoning and should be revisited.

Add an upland requirement for building lots to prevent encroachment on wetlands.

As a supplement to OSD/NRPZ or as a standalone measure, the addition of an upland requirement for building lots would stipulate that a certain percentage of the lot must be dry land (i.e., not a wetland) to prevent negative impacts on water resources and subdivision of non-buildable lots.



Participate in Route 116 Scenic Byway Corridor Management Plan.

Views along the Plainfield stretch of Route 116 are particularly representative of the rural character valued by both residents and visitors and should be kept consistent with that character. Plainfield could consider a scenic upland zoning bylaw to protect its major views, including mountains, ridgelines, and hillsides, which are also often fragile and highly susceptible to environmental damage during and after development. It is recommended that Plainfield consult with other municipalities along the Byway regarding strategies that these towns may be using or considering under the *Route 116 Scenic Byway Corridor Management Plan* developed by FRCOG. Additional benefits of such a collaboration could include increased revenue for local farming, craft, and forest-related businesses in town if better highlighted through town signage and Byway visitor guides, as suggested in the Plan.

Revisit potential to approve the Community Preservation Act.

The CPA is considered a Smart Growth tool that is designed to help communities preserve and improve their character and quality of life. Participating communities institute a surcharge of up to 3% on property taxes, the funds from which are put into a local Community Preservation Fund which can be used for preserving open space and historic sites and creating affordable housing and outdoor recreation opportunities. Communities then become eligible to receive additional annual funding distributions from a statewide Community Preservation Trust Fund. These allocations can be used among the three categories above at the town's discretion and can be saved up over time. A survey distributed as part of the 2013 *Plainfield Master Plan Land Use Chapter* community outreach indicated that about half of respondents did not support a CPA measure at that time, although there were only around fifty respondents and it is unknown whether this was subsequently brought to an actual town vote. While the idea of a surcharge may be unappealing to some

The Community Preservation Act at Work

Town of Goshen: CPA established 2007. 2009-2016: 15 projects, $1.7 million total funding to date

Town of Conway: CPA established 2004. 2006-2013: 14 projects, $1.9 million total funding to date

Community Preservation Coalition database, 2022

residents, many towns exempt certain income ranges and/or the first $100,000 in property value, which can lower the burden.

Incorporate Resilience Into Community Space Projects

In addition to planning for future development, there are opportunities to increase resilience in existing community spaces through upgrades to critical infrastructure, protection of utilities, preservation and replacement of trees and vegetation, and enhancing pollinator habitat.

Implement measures to expand the capacity of the Public Safety Complex to serve as a community support center.

The Public Safety Complex is currently the Town's designated emergency shelter and has a dedicated water supply as well as a permanent propane generator for back-up power and a limited supply of non-perishable food items in storage. The Complex can be used as a warming/cooling center if necessary, and has also served to host occasional community or larger private events. This is a valuable asset for the community and the Town should consider how its capabilities could be further enhanced, with an eye towards potential lack of fossil fuels in the future. Possible measures could include bolstering water supply and treatment capacity, constructing a hybrid energy system with solar PV and battery storage for extended supply during outages, and improving community/recreation space available for both normal and emergency conditions.

Continue replacement of roadside trees using native species.

Most of the potentially hazardous trees along Plainfield's roadways are sugar maples in deteriorating condition due to age and climate-related stress; these trees will continue to struggle with rising temperatures from climate change. Ideal replacement tree species will be expected to thrive in Plainfield's current plant hardiness zone as well as potentially warmer, wetter, and periodically droughty conditions; attain a mature size not anticipated to interfere with utility lines; and provide shade, beauty, and habitat for native wildlife. The Tree Warden and Tree Alliance, among other groups, have been proactive in gathering extensive information and resources on climate-appropriate and high-habitat-value native species and planting them in town.

Replace and expand vegetation on municipal rights of way and community spaces using native species.

Vegetation, in addition to shade trees, adds significantly to aesthetics and community character. Spaces such as town parks, sidewalk strips, and other planting beds have great potential to provide both aesthetic benefits and support critical native pollinators if planted with locally appropriate species.

Direct residents interested in tree- or pollinator-planting projects on their own lands to appropriate resources.

The Tree Alliance, Tree Warden, and Conservation Commission are local repositories for useful information on regional and climate-appropriate species.

Summary & Closing

RECOMMENDATIONS

The following tables provide a summary of the recommendations presented in the preceding chapters of this Plan.

AC: Agricultural Commission; BD: Building Department; CC: Conservation Commission; EC: Energy Committee; ER: Emergency Response; HC: Historic Commission; HD: Highway Department; PB: Planning Board; TA: Tree Alliance; ZBA; Zoning Board of Appeals

ECOSYSTEMS & BIODIVERSITY

Recommendations	Responsible Parties	Timeframe
Strategy: Make land justice a top priority		
Involve local native people and other communities most oppressed by settler colonization from the beginning of all discussions involving ecosystem conservation.	All	Short to long
Strategy: Protect biodiversity and important habitat		
Prioritize protection of patch habitat parcels within the Important Plant Area (IPA) for conservation.	Selectboard, CC, PB	Short to long
Consider bylaws and/or zoning tools to protect important habitat and species outside the IPA.	PB, ZBA, CC	Medium to long
Conduct a natural and cultural resources inventory that provides a portfolio of the significant natural, cultural and historic resource areas of Plainfield's forests.	CC, HC	Medium
Update the Open Space and Recreation Plan (OSRP).	Selectboard, CC, ER	Medium
Strategy: Manage forests for climate resilience		
Continue and expand efforts to educate landowners about sustainable forestry practices and incentive programs.	CC, TA	Short
Work with land trusts and state agencies to understand management priorities and discuss preferred management strategies for critical locations (i.e., sensitive habitats, transitional forest).	Selectboard, CC	Short to Medium
Consider Community Forest opportunities.	Selectboard, CC, landowners	Medium to long

WATER RESOURCES

Recommendations	Responsible Parties	Timeframe
Strategy: Protect riparian forests and vulnerable waterways		
Continue with efforts to revise town wetlands bylaw for enhanced protection around sensitive aquatic resources.	CC	Short
Connect farmers and other individual property owners with grants and programs to establish riparian buffers along streams and wetlands.	AC, Landowners	Short to medium
Consider land protection along vulnerable riparian areas.	CC	Medium to long
Advocate for state bill S.1875/H. 2831 to ensure compensation for watershed and ecosystem protection through the State Owned Land (SOL) PILOT program.	Selectboard, all residents	Short
Consider conducting a fluvial geomorphic assessment to identify river restoration opportunities	CC, HD, Selectboard	Medium
Strategy: Guide new infrastructure and development with water in mind		
Update culverts and road crossings in areas at high risk of flooding and erosion.	HD	Short to long
Consider adding stormwater bylaw language that requires low impact best management practices for new construction.	BD, PB, ZB	Medium to long
Strategy: Identify and reduce contaminants in surface waters and groundwater supply		
Consider the Water Quality Management Planning Grant Program to conduct full-profile water quality testing at key surface and groundwater locations.	BH, CC	Short to medium
Develop a salt reduction program including the establishment of reduced salt areas near important water resources.	CC, HD	Short to medium

AGRICULTURE & FOOD SYSTEMS

Recommendations	Responsible Parties	Timeframe
Strategy: Implement strategies from the MA Smart Growth / Smart Energy Toolkit to preserve agricultural land		
Participate in the Farm Viability Enhancement Program (FVEP).	AC	Medium
Use the Agricultural Commission to connect farmers with other potential sources of funding through the Massachusetts Department of Agricultural Resources.	AC	Medium
Strategy: Preserve and enhance Plainfield's agricultural capacity		
Prioritize preservation of remaining unprotected prime/important farmland for agricultural use; consider allowing provisions in APRs or other conservation easements that allow for appropriate new technologies, such as qualified agrisolar systems.	AC, PB, Selectboard	Medium to long
Advocate for state incentives and investments in climate-friendly farming solutions.	AC	Long
Use the Agricultural Commission as a "clearinghouse" to help connect current and prospective farmers with land, housing, information, and other resources and develop farming succession plans.	AC	Medium to long
Consider strategic conversion of reforested prime farmland to pasture or cropland.	AC, landowners	Medium
Strategy: Promote small-scale local food production		
Pursue a regional collaboration or study regarding community food systems; contact Hilltown CDC as a potential partner.	AC	Short to medium
Organize and host community education sessions on home food production, preservation, and storage; support small-scale food production in community gardens and residential plots.	AC	Short

ENERGY SYSTEMS

Recommendations	Responsible Parties	Timeframe
Strategy: Plan for energy efficiency and decarbonization		
Continue Energy Committee activities around tracking energy use, emissions, and progress towards reduction targets for municipal buildings under the Green Communities program.	EC	Short
Formalize a community-wide vision for energy conservation measures and generation from renewable sources as part of a Comprehensive Plan.	EC, PB, AC, ZBA, CC	Medium
Discuss status and options regarding substation capacity and interconnections to establish feasibility limits for local renewables.	EC	Short
Consider supporting renewable energy by opting in to utility programs encouraging renewable energy certificates for energy use in municipal buildings.	EC, Selectboard	Short to medium
Build environmental protections into solar regulations.	EC, ZBA	Medium
Keep abreast of federal, state, and regional funding and incentive programs related to municipal and residential energy; provide regular updates to residents.	EC	Medium to long
Strategy: Build with energy efficiency and renewables in mind		
Take advantage of Green Communities grant funds to implement heating/cooling systems and energy retrofits in municipal buildings.	EC, BD	Short
Require projects of a certain size or type to meet green building standards such as LEED, Energy Star, or net-zero. For smaller projects, consider options to incentivize green building and energy efficiency practices, such as expedited permitting.	EC, BD	Medium to long
Create and distribute educational materials detailing benefits of and strategies for ecological building and site design and high efficiency technology options for residential homes.	EC, BD	Short to medium
Design capacity for renewables into all renovations/upgrades for municipal properties.	EC, BD	Medium to long
Strategy: Decrease vulnerability of existing energy infrastructure		
Continue working with Eversource to coordinate preventative tree maintenance activities. Educate residents about hazard trees and the responsibilities of the Tree Warden.	Tree Warden	Short
Bury electrical lines wherever possible.	Eversource, HD	Long
Consider battery back-up for any new municipal solar PV systems to extend power availability during grid outages.	EC, BD	Medium to long

COMMUNITY INFRASTRUCTURE & DEVELOPMENT

Recommendations	Responsible Parties	Timeframe
Strategy: Plan for Smart Growth		
Update and expand the existing Plainfield Master Plan to include broader evaluations of socioeconomic elements.	EC, PB, AC, ZBA, CC	Medium to long
Revisit Open Space Design/Natural Resource Protection Zoning as an alternative to Approval Not Required.	PB, ZBA, CC, BD	Long
Add an upland requirement for building lots to prevent encroachment on wetlands.	PB, ZBA, CC, BD	Long
Participate in Route 116 Scenic Byway Corridor Management Plan.	PB, ZBA, CC, HC	Short to medium
Revisit potential to approve the Community Preservation Act.	PB, ZBA, CC, HC	Medium to long
Strategy: Incorporate resilience into community space projects		
Implement measures to expand the capacity of the Public Safety Complex to serve as a community support center.	EC, BD, ER	Medium to long
Continue replacement of roadside trees using native species.	CC, TA, Tree Warden	Short
Replace and expand vegetation on municipal rights of way and community spaces using native species.	CC, TA, HD	Short
Direct residents interested in tree- or pollinator-planting projects on their own lands to the Tree Alliance, Tree Warden, and Conservation Commission for resources on regional and climate-appropriate species.	TA, Tree Warden, CC	Short

FUTURE CONSIDERATIONS

The recommendations given in Chapter 6 (Community Infrastructure & Development) are broadly intended to reduce negative environmental impacts of gradual current and near-term future residential and commercial development in Plainfield and preserve as much of the rural and historic character of the town as possible. However, in the coming decade, Plainfield should re-evaluate development trends, weigh the probability of significantly increased development pressure, and consider the benefits and challenges of concentrating all or part of proposed infrastructure in a formalized town center.

For the nearer term, this Plan has provided a variety of recommendations to improve climate resilience for Plainfield to consider. It is recognized that the Town depends largely on volunteers who may not have the time or resources to take on additional responsibilities. Many of the recommendations put forward in this Plan involve identifying and pursuing funding from outside grant programs and other sources. The Town would benefit greatly from having a dedicated staff member who could lead these efforts and support the Town Boards and Committees with other record-keeping and communications needs. One option that the Town could evaluate would be to put a portion of each Board's budget towards supporting a paid administrative assistant position to meet these needs.

CLOSING REMARKS

This Climate Resilience Plan provides an overall vision for Plainfield that reflects the values of the community, and also speaks to some of the challenges and difficult choices that the town is facing. The CRP highlights the importance of supporting both ecosystem function and local economies by protecting the important habitats needed to sustain biodiversity and promoting healthy forest management practices. To ensure the health of its waters and the town's flood resilience, it is particularly important to protect the forests and natural vegetation immediately surrounding streams and wetlands.

Power outages and energy resilience are a concern in the community and the thoughtful incorporation of renewable energy may play an important role in reducing fossil fuel use and improving the reliability of energy supplies. However, the use of large-scale solar presents a significant potential conflict with other land uses in Plainfield. It will be important to establish to what extent the community wants to or can feasibly have large scale solar as part of its energy vision. In the meantime, existing solar regulations can be amended to provide increased protection to critical natural resources, and all possible steps should be taken to address energy efficiency and preparedness to reduce the overall demand and improve residents' ability to cope without grid power.

Other forms of development, such as residential or commercial, may also present the community with difficult land use decisions. Although it may be hard to imagine today, it is likely that Plainfield will experience increased development pressure in the future, and should act now to have appropriate guidance in place to minimize the potential impacts on valuable natural resources and the visual character of the town. If possible, development that does occur should improve community resilience by promoting strong social connections and access to vital support systems.

No town is an island, and Plainfield, with its location at the top of the watershed and extensive forests linking regional ecosystems, is in an excellent position to participate in cross-boundary study and collaboration at the watershed or even regional scale. These should be particularly encouraged around food and energy systems as well as existing and upcoming developments around forest management for climate change and carbon mitigation.

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Appendix A: Climate Action Planning for Individuals and Municipalities

Sustainable Economies Law Center

OPTIONS FOR TRANSFERRING LAND

A BRIEF GUIDE

This short guide summarizes various options for landowners interested in transferring land to another person, group, or community. Landowners who are particularly interested in transferring ownership to nonprofit land trusts, indigenous tribes, and community-based organizations will find this guide most useful.

Because we have written this guide with landowners in mind, we also provide a brief consideration of the advantages and disadvantages of each option from that perspective. Having said that, we think it is essential that landowners consider their own goals as well as the goals and needs of the party or community to whom they would like to transfer land.

Four key questions to consider as you read through this guide focus on the *financial* and *use* needs of the parties.

1. What are the **financial needs** of the transferring party?
2. What are the **financial needs** of the receiving party?
3. What are the **use needs** of the transferring party after the transfer?
4. What are the **use needs** of the receiving party after the transfer?

The land transfer mechanisms covered in this guide include:

- Full Value Sale
- Charitable (Bargain) Sale
- Full Donation
- Donation of a Remainder Interest
- Revocable Transfer on Death (Lady Bird Deed)
- Donation by Bequest
- Sale or Donation of an Easement

In any situation, we strongly recommend that you seek individualized tax, legal, and estate planning advice to determine which of these options is best suited to your circumstances. Laws vary from state to state, so having appropriate counsel where the land is located is critical.

Full Value Sale

This is likely the kind of transfer of ownership that most people are familiar with. In this scenario, the landowner sells to the buyer at a price determined by a third-party appraisal. The buyer pays the full value and receives title to the property. For many people, including nonprofits and other community-based organizations, a full value sale is not an affordable option. However, there are ways to make this option more affordable by delaying payment in two ways.

1. **Installment Sale:** An installment sale allows the buyer to make payments over several years at intervals and amounts that are agreeable to both parties. The landowner would retain title to the property until the final payment. The parties could agree to provide the buyer with use of the land at any point during the payment period, including at the first payment or after payment has been made in full.
2. **Seller Financing:** Alternatively, the landowner could provide seller financing, meaning that title immediately transfers to buyer, and in exchange, the landowner gets a promissory note in which the buyer promises to pay the landowner over time, with or without interest. A deed of trust is recorded on the property to secure payment of the promissory note.

Advantages of this option:

- Fee simple ownership of land gives the buyer the greatest ability to fulfill their mission and ensure secure tenure over the long term.

Disadvantages of this option:

- The landowner will have to pay income tax on the capital gain if the land has appreciated in value since it was originally purchased.
- This is the least financially feasible option for buyers, particularly nonprofit organizations with a limited budget and limited capacity to raise capital.
- An installment sale may limit the buyer's uses of the land until the transfer is complete.

Charitable (Bargain) Sale

A charitable, or bargain, sale occurs when the landowner sells land *to a tax-exempt nonprofit* organization for less than market value. This kind of sale makes the land more affordable to the buying nonprofit, and can offer tax deduction benefits to the selling landowner. The parties can also use the **Installment Sale** or **Seller Financing** options discussed above in this situation as well, if affordability is still a concern for the nonprofit buying the land.

Advantages of this option:

- The difference between full market value and the sale price can qualify the landowner for an income tax deduction and capital gains tax reduction for that portion of the value. This can offset the income taxes and capital gains taxes the landowner will incur from the sale of the property, after reducing ordinary income.
- If the land has significantly increased in value since the seller purchased it, this option can offset a large amount of the resulting capital gains liability for the increased value.
- The nonprofit buyer will be more likely to afford the purchase price of the land.

Disadvantages of this option:

- The landowner does not realize the full income from the market value of the property.
- This may not be the best strategy if the landowner would otherwise qualify for public benefits in the next several years. Recently transferred assets like land can negatively impact eligibility for benefits.

Full Donation

This is the simplest way to transfer land to another party and is the most affordable option for receiving nonprofits or community-based organizations to advance their mission to protect, preserve, and steward land in the long term.

Advantages of this option:

- Fee simple donation to an eligible tax-exempt organization would give the landowner the greatest immediate income tax benefits, sometimes for the full appraised value of the land, in addition to relief from property taxes, and potential estate tax benefits.
- The receiving party would not require financing in order to receive the land.
- The land would be immediately available to the receiving party.

Disadvantages of this option:

- The landowner does not realize the full income from the market value of the property.
- This may not be the best strategy if the landowner would otherwise qualify for public benefits in the next several years. Recently transferred assets like land can negatively impact eligibility for benefits.

Donation of a Remainder Interest

If the landowner would like to donate the land to an eligible tax-exempt nonprofit organization but retain the ability to live on the land during their, or their family members', lifetime, they can donate what is called a "remainder interest" in the land while retaining what is called a "life estate."

Advantages of this option:

- Full transfer to the receiving party will occur immediately upon the landowner's death. Upon the landowner's, or their designated family members', death, this kind of transfer avoids the expense and delay of probate.
- The landowner may be able to receive an immediate income tax deduction for the value of the property that was donated (determined by an appraisal).
- This may be a good option for landowners who receive public benefits. The state can make a claim for repayment of these benefits against an estate and place a lien on property after death. However, because donating a remainder interest is irrevocable, the property will not be part of the estate at death.
- The land will not be subject to capital gains tax on appreciated value.
- The property will not be part of the donor's taxable estate, where the donor (and/or the donor's spouse) are the only life tenants.

Disadvantages of this option:

- The landowner will need to pay the property taxes on the land while retaining use of the property.
- The landowner does not realize the full income from the market value of the property.
- The receiving party would not require financing in order to receive the land.
- Without another agreement, the land will not be immediately available for use by the receiving party.

Revocable Transfer on Death Deed (Lady Bird Deed)

Lady Bird Deeds, which are only available in some states, are similar to deeds described above that create a life estate and donate a remainder interest, except that Lady Bird Deeds are revocable, meaning that the landowner can, during their lifetime, revoke the transfer. This gives more control to the landowner, but can put the receiving party in an uncertain position. Lady Bird Deeds are available in California until 2021, unless legislation is introduced to extend the law.

Advantages of this option:

- Transfer of title will occur immediately upon the landowner's death, so the donation will not be subject to the expense and delay of probate.
- The land donation will not be subject to capital gains tax on appreciated value.
- The landowner can revoke the deed at any time during their lifetime.

Disadvantages of this option:

- Because the deed is revocable, the landowner does not receive an income tax deduction available with other land donations.
- Without another agreement, the land will not be immediately available to the receiving party.
- The receiving party would not require financing in order to receive the land.
- This kind of transfer does not provide reliable certainty to the receiving party since the transfer can be revoked during the landowner's lifetime.

Donation by Will or Living Trust (Bequest)

A landowner can donate land in a will or through a revocable living trust. Both strategies allow the landowner to retain full use of the land during their lifetime.

Advantages of this option:

- Reduces estate or inheritance taxes.
- Can be changed or revoked at any time during landowner's lifetime.
- The receiving party would not require financing in order to receive the land.

Disadvantages of this option:

- The landowner will still be responsible for paying property taxes for the entire property during their lifetime.
- Without another agreement, the land will not be immediately available to the receiving party.

Agricultural, Conservation, or Cultural Easement Donation

An *easement* is an agreement between the landowner and a third party that affects the landowner's rights on the land covered by the easement. Easements are generally recorded on the deed of the property and are therefore permanent. Conservation, agricultural, and cultural easements are specific kinds of agreements that can be entered into with eligible organizations or tribes that can also qualify as a charitable contribution if donated by the landowner.

- A *conservation easement* permanently restricts uses on the land that interfere with the ecological conservation of that land.
- An *agricultural easement* permanently protects farmland by setting limitations on the use of the land.
- A *cultural easement*, available in some states, grants indigenous communities certain access rights to lands for continuing and preserving cultural heritage.

Easements can be sold or donated. The party holding the easement cannot also be the party that holds title to the land.

Advantages of this option:

- The landowner can retain ownership of the land and convey the land to their heirs.
- If the easement meets IRS criteria, the landowner may be able to deduct the value of any donated portion of the easement up to 50% of their adjusted gross income, or 100% if they are a farmer, for up to 15 years.
- Affirmative easements (those requiring certain uses) can increase the value of the easement and reduce the overall value of the land, making it more affordable if the easement is sold instead of donated
- In addition to an income tax deduction, the easement may reduce property taxes and estate taxes.

Disadvantages of this option:

- Easements do not convey an ownership interest in the land to the party holding the easement. This may not align with the intent of either or both parties.
- Easements can be expensive to enforce, thus creating a financial liability for the easement-holding party.
- Easements, alone, do not preserve long-term affordability of land, because an easement only reduces the relative market value of the land, but does not immunize the land value from increasing through speculation and other market forces.

Forest carbon, net zero, and climate action planning

Key Considerations for Massachusetts Municipalities

Many governments, businesses, and other organizations are establishing net-zero carbon emissions goals to fight climate change. For towns in Massachusetts, achieving net zero often entails developing a Climate Action Plan, or roadmap to emissions reductions for each sector of the economy.

Reaching net zero will require both reducing emissions that can be reduced, and offsetting those that can't by increasing carbon sequestration through other means. Nature based solutions (NBS) to climate change include protecting the carbon storage and sequestering ability of natural lands, especially forests. Thus, protecting forests and improving their management can contribute to net-zero goals.

What We Know

Forest carbon storage and sequestration is an important nature-based solution, but there is a limit to how much carbon can be sequestered. NBS by themselves cannot solve climate change; emissions reductions are also necessary. Therefore, forest carbon should only be used to offset emissions that are the most difficult to reduce by other means.

Management influences forest carbon and resilience—human actions affect how much carbon is stored in a forest now, how rapidly the forest sequesters carbon, and the stability of both storage and sequestration over the long term (resilience). Climate-smart forestry practices seek to maintain and improve sequestration, storage, and resilience, and include both active and passive approaches.

Protocols and programs exist for measuring and selling forest carbon—In Massachusetts, forest carbon projects have been developed for both the voluntary and California regulatory markets, with landowners selling carbon to polluting entities to offset those emissions. Mass Audubon and DCR have developed a guide to forest carbon projects for municipalities.

What We Don't Know

Climate regulations are evolving—Existing frameworks for carbon accounting include both voluntary and regulatory approaches. However, we don't know what the future regulatory environment will look like for emissions reductions in different sectors, and the market or policy mechanisms for doing it—at the state, national, and international level. Future state or national policy may incentivize or disincentivize market approaches to carbon crediting.

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Opportunities for Municipal Action

In absence of state policy, towns have decision-making power about where their emissions are counted. When developing conservation projects or Climate Action Plans to benefit municipal forests, municipalities may consider a variety of actions.

Depending on the goals of your town and the timing of activities, some of these actions may be combined with each other or with a market-based forest carbon offset project. It's important to seek advice early on about the near-term and long-term approaches your town is interested in.

Conduct a forest inventory. Perform a GHG inventory of municipal forest land to determine its contribution to climate change mitigation in your town—or emissions due to development.

Plan for climate adaptation. Get a Forest Stewardship Climate Plan for any municipal forest land with the help of a licensed consulting forester through the Department of Recreation and Conservation Service Forestry.

Implement climate-smart forestry practices. Work with a licensed consulting forester to implement recommended actions from your Forest Stewardship Climate Plan to boost carbon sequestration or storage and support forest adaptation to climate change.

Protect existing trees and forest from development. Keep land forested!

- Add a Conservation Restriction to any non-protected municipal forest land. Permanent protection of landscapes like Bear Hole in West Springfield promote key co-benefits like wildlife habitat, flood mitigation, and carbon sequestration—and contribute to municipal resilience.
- Enact, revise, or strengthen bylaws to support tree planting, maintaining tree cover, and tree protection. Metropolitan Area Planning Council's Climate Resilient Land Use Strategies tool gives examples of climate resilience bylaws in different sectors. DCR also offers a guide to bylaws and ordinances focused on trees.
- Enforce the Wetlands Protection Act: Wetlands of all kinds store large amounts of carbon. Protecting wetlands from development means avoiding significant carbon emissions in addition to protecting water quality and biodiversity.

Key Terms to Know

Forest carbon project: an individual, nonprofit, government , or private company commits to managing their forest for carbon sequestration for a specified length of time. The additional carbon produced is quantified and sold as credits to offset the carbon emissions of a polluting entity

Net zero: the emissions produced within a jurisdiction are balanced by the amount of carbon sequestered

Climate action plan: report that establishes an emissions reduction goal and outlines near and long-term strategies across different sectors of the economy to meet this goal

Carbon accounting: the method used to measure and summarize carbon emissions, reductions, sequestration, and storage at a specific level (e.g. individual, company, state)

Double-counting: claiming emissions reductions from a carbon project twice

Carbon storage: the carbon amassed in a forest that is held in trees, dead wood, leaves, and soil

Carbon sequestration: process in which trees take in carbon dioxide from the air and convert it to solid plant tissue in their trunks, branches, roots, and leaves

Nature-based solutions: actions that promote the natural benefits of our ecosystems to address environmental challenges or societal needs (IUCN, 2021)

Opportunities for Municipal Action—Continued

Increase tree cover in urban areas and underserved communities. Work to reduce inequities and the urban heat island effect while promoting carbon sequestration, stormwater filtration, flood mitigation, clean air, and community health.

- Conduct an urban tree inventory or tree canopy assessment, or develop an urban forest plan.
- Develop forest gardens in underserved neighborhoods to produce food and expand or enhance green space and fostering community resilience.
- Create pocket parks on vacant or ill-sized lots - check out example parks in Cambridge and Medfield, MA.

Enhance soil carbon. The January 2021 Economic Development Bill included a Healthy Soils Amendment. Massachusetts is now developing a framework to implement programs like the MA Coordinated Soil Health Program to improve soil health and enhance carbon sequestration.

Set up a local carbon fund. Businesses or individuals within the municipality contribute to emissions reductions projects in the community, such as energy efficiency projects. Example funds include the Finger Lakes Carbon Fund and the Monterey Bay Offset Fund.

Develop forest carbon offset project. This market-based approach offers many benefits: towns can sell their carbon, pay for the project, protect their land for decades, and generate funding for other conservation initiatives. However, if contributing to local emissions reductions is important, buyer location matters. Projects can help municipalities meet net-zero goals, but only if carbon credits are accounted for *within the town.* If a town (or other entity) sells carbon credits to a buyer outside the town, that carbon can no longer be counted towards town-level net-zero goals.

For towns and cities interested in learning more, Mass Audubon is available to consult about different approaches to forest stewardship and protection. Reach out to us to discuss your town's ideas (climateforestry@massaudubon.org).

How to Fund This Work

There are numerous state and federal programs available to fund these activities. Listed below is a snapshot of options and the action pathways that they support.

- **Forest Stewardship Program** (**DCR**): Plan for climate adaptation, implement climate-smart forestry practices on municipal land
- **Municipal Vulnerability Preparedness Program** (**EEA**): Supports most action pathways – discuss with your local representative.
- **Natural Resources Conservation Service**: Plan for climate adaptation, implement climate-smart forestry practices on private land, increase tree cover
- **Greening the Gateway Cities Program**: Increase tree cover in urban areas and underserved communities.
- **City Forest Credits**: Develop forest carbon offset project, increase tree cover in urban areas and underserved communities
- **Community Forest Program** | USFS: Protect trees from development
- **Northeast Sustainable Agriculture Research and Education**: Enhance soil carbon

Appendix B: Example Dual-Use Solar Installations

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Smart Solar Siting for New England

The rapid expansion of renewable energy installations across the region in recent years has brought new and pressing challenges. Solar deployment is becoming constrained because of increasing conflict over the pressure that projects are putting on farms and forests. This new pressure compounds the severe "competition for land" in New England due to residential development, expanded local food production, and climate change. Dual-use solar arrays provide a productive alternative to traditional ground mount solar – one that maintains agriculture on site, under or around the solar installation itself.

What is Dual-Use Solar?

The definition of dual-use solar varies across state lines, industries, and organizations. For this project we use the following working definition:

Dual-use solar, also known as **agrivoltaics** or **co-location** of solar, is the practice of installing solar photovoltaic panels on farmland in such a manner that primary agricultural activities (such as animal grazing and crop/vegetable production) are maintained simultaneously on that farmland.

The following examples of dual-use solar projects vary in design, size, agricultural production, and location. This document is meant to highlight the variety of settings dual-use can work.

Examples of Dual-Use Solar Arrays

French National Institute for Agricultural Research, Montpellier, France[1]

Figure 1: Photos by Hélène Marrou

Excerpt from The Resurgence of Solar Agriculture - Harvesting food and energy side by side[2]

Researcher Hélène Marrou explained, for example, that the lettuce adapted to low light by increasing leaf size. She also wrote in a 2013 paper that in a warming world where water could be in short supply, shading plants under solar panels could reduce the need for water. "We showed in this experiment that shading irrigated vegetable crops with PVPs (photovoltaic power systems) allowed a saving of 14 percent to 29 percent of evapotranspired water, depending on the level of shade created and the crop grown.

"The takeaway is that too much shade can hurt the crops. And too little can hurt electricity generation. Proper spacing between the solar panels, together with the tilt of the arrays, is key to getting the right mix of electricity and crop production."

[1] Marrou, H. Co-locating food and energy. Nat Sustain 2, 793–794 (2019). https://doi.org/10.1038/s41893-019-0377-0
[2] https://anthropocenemagazine.org/2018/09/the-resurgence-of-solar-agriculture/

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University of Massachusetts Amherst Research Farm, South Deerfield, MA

Excerpt from Agriculture and Solar Energy Dual Use[3]

Figure 2: Photo by Emily Cole

This research project is grounded in the understanding that there is a need for sustainable renewable energy sources for Massachusetts and the U.S. and we suggest solar power as an area of great promise…Only solar has the potential to substantially power the state while only using a reasonable amount of the state's land mass. Traditional ground mounted solar installations on farmland, however, remove arable land from potential agricultural use.

In the project's first phase, installation techniques were developed as 106 panels were installed in livestock pasture areas. New techniques were developed to install (drive) poles with no disturbance to the soil or crop underneath. At the same time, methods were developed to create stable structures without the use of large concrete bases which would have also created excess disturbance to the soil. Panels were installed about 7.5ft (2.3m) off the ground with spaces between panel clusters varying from 2 to 5ft.

Figure 3: Herbert et al., 2017.

Preliminary results show minimal effect of biomass when land under the panels is in pasture; benefits in vegetable production during drought conditions; and depressed harvest under normal conditions. While a formal report is not yet released, it has been reported, preliminarily, that peppers, broccoli, and Swiss chard grew to about 60 percent of the volume they would in full sun, while the panels produced half the power per acre of a traditional system.

Grazing Cattle at Maple Ridge Meats, Benson, Vermont

From Rural Solar Stories, a project of Environmental Law & Policy Center[4]
A new Vermont project demonstrates how to maintain agricultural use of the land with on-site solar. When Greg Hathaway started his organic beef processing plant, Maple Ridge Meats, he sought to lower their power costs and increase sustainability with solar. Working with the Vermont Agency of Agriculture and a local renewable energy developer, they pioneered a new style of solar array to be built on their pasture to partly power their operations.

Figure 7: Raised Array at Maple Ridge Meats. Source: ruralsolarstories.org

On hot summer days the cattle seek relief from the sun, lined up in the shade of the panels. It's even become a local attraction for passersby who park along the country road. This approach could be used for cattle grazing elsewhere in the country, especially the Midwest and Great Plains.

[3] Herbert, S. J., Ghazi, P., Gervias, K., Cole, E., & Weis, S. (2017). Agriculture and Solar Energy Dual Land Use.
[4] ruralsolarstories.org/farm-friendly

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Solar Sharing in Japan

Figure 4: Photo of Solar Sharing Field Test via Akira Nagashima[3]

Excerpt from Japan Next-Generation Farmers Cultivate Crops and Solar Energy[5]

At first glance, the structure may seem to be rather "skimpy." One of reasons is the MAFF [Ministry of Ag, Forestry, and Fisheries] *requires that PV systems have a simple structure (without concrete footings) and should be easily dismantled. MAFF also requires that PV mounting structures must be designed and built to secure adequate sunlight for crops and space for agricultural machinery to be able to move around.*

However, Nagashima said that the point of these guidelines are for farmers to remain "farming" and prevent farmers from fully converting productive farmland to solar facilities. Based on the tests conducted at his solar testing sites in Chiba Prefecture, he recommends about 32% shading rate for a farmland space to reach adequate growth of crops. In other words, there is twice as much empty space for each PV module installed. To ensure continuous farming, municipal agricultural committees require farmers to report annual amounts of cultivation and demand to take down the PV system from the land if the amount of crops cultivated on the solar shared farmland gets reduced by more than 20%, compared to the pre-PV installation.

Figure 5: Solar sharing Power Plant Oo in Tsukuba, Japan[5]

[5] https://www.renewableenergyworld.com/2013/10/10/japan-next-generation-farmers-cultivate-agriculture-and-solar-energy/#gref
[6] https://solar-sharing-japan.blogspot.com/

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Grazing Sheep at Open View Farm, New Haven, Vermont

Open View Farm is home to a 2.49 Megawatt DC solar array, which produces enough energy annually to power 350 to 400 homes. From the beginning, one of the project goals was to incorporate sustainable energy with sustainable agriculture and have sheep graze within the solar array, mitigating the need for the grass beneath the panels to be mowed regularly, while providing prime pasture for sheep.

Figure 6: © Openview Farm

From VT Guide to Farming-Friendly Solar, by Vermont Agency of Ag, Food, Markets[7]

Once constructed, a woven wire fence was placed around the entire array. The disturbed ground beneath was seeded with a sheep-grazing mix, with some additional birdsfoot trefoil and clovers added as it is a clay type soil that dries out quickly in late summer if there is no precipitation. Anna has noticed that the bees also benefit from the clover blossoms in the solar array, especially after the surrounding hay has been harvested. Anna and Ben partition the acreage inside the fence for a rotational grazing system, aligning their fences with the rows of solar panels.

[7] https://www.uvm.edu/extension/sustainableagriculture/guide-farming-friendly-solar

For resources and more information on the New England Smart Solar Siting Partnership please visit:
https://farmland.org/New-England-solar

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Appendix C: Best Practices for Solar Siting

MAINE FARMLAND TRUST

For more information, please contact:
Eliza Donoghue at edonoghue@maineaudubon.org.

"Best Practices" developed by:

November 2019

BEST PRACTICES

for Low Impact Solar Siting, Design, and Maintenance

Avoiding and Minimizing Impacts to Natural and Agricultural Resources

Increasing renewable energy production in Maine is critical to mitigating the impacts of climate change on Maine's natural resources and agricultural and natural resource based economies. Solar projects that follow these low-impact best practices will help Maine people, businesses, and communities realize solar's climate and economic benefits, while avoiding or significantly reducing undue impacts to wildlife, farming, and critical natural resources such as clean water.

The purpose of this document, authored by Maine-based environmental and agricultural nonprofit organizations, is to advise solar developers, municipalities, and the public about ways to avoid or minimize development conflicts. It is not meant to supercede required federal, state and municipal permitting; likewise, we recommend using these best practices regardless of permit requirements. It is also important to note that solar development is subject to other considerations, including interconnection, project economics, and other siting constraints.

photo: Carl Lender/FLCKR

photo: Michelle Callahan/FLCKR

Natural Resource Siting Best Practices

(1) **Preferentially use disturbed, developed, or degraded lands.** This includes landfills, brownfields[1], roadway medians and edges, parking lots, rooftops, idle or underutilized industrial or commercial sites, and sand and gravel pits. Utilizing disturbed lands avoids new forest clearing, minimizes soil disturbance, and takes advantage of unutilized or underutilized space.

(2) **Avoid where practical, and minimize as much as possible, impacts to sensitive wildlife habitats and high-value natural resources.** This includes all habitats identified as "Significant Wildlife Habitats" under Maine's Natural Resources Protection Act, as well as additional areas and natural communities deemed to be rare or particularly sensitive to encroachment.[2] Other sensitive habitats include threatened and endangered species habitat, rare plant populations, cold-water fish habitat, wetlands, eelgrass beds, rare natural communities, Focus Areas of Statewide Ecological Significance, forested areas that have not previously been cleared for agriculture, and resilient and connected landscapes.[3]

A desktop evaluation of these resources should not take the place of detailed, site-specific investigations of any proposed site to identify any unmapped habitats, species, or resources present at the site. Likewise, it should be recognized that GIS mapping may not be accurate and site specific investigations may supercede GIS mapping.

In all circumstances, preference should be given to avoidance, with minimization and compensation utilized only where avoidance is not possible.

(3) **Avoid where practical, and minimize as much as possible, impacts to intact forest landscapes.** Intact forest landscapes are areas with no significant human development or long-term habitat fragmentation and that provide relatively undisturbed habitat conditions. They are critical for increasing carbon storage, harboring biodiversity, regulating hydrological regimes, and providing other essential ecosystem functions.

(4) **Allow for habitat connectivity by avoiding or minimizing impacts to wildlife corridors; locating projects near existing transmission and distribution infrastructure, highways and population centers; co-locating new transmission infrastructure; and using wildlife-friendly fencing.** Wildlife corridors include migration corridors for terrestrial wildlife, aquatic corridors, and climate corridors utilized by wildlife as habitats and home ranges shift in the face of climate change. Likely upland and wetland habitat connectors are depicted on Beginning with Habitat maps, but terrestrial migration corridors aren't as thoroughly mapped. Site-specific information, as well as conversations with natural resource agencies and local nonprofit organizations, may be needed to properly avoid impacts.

Co-locate new transmission lines with existing man-made linear features, wherever possible. If co-location is not possible, utilize routes that have the least overlap with high value natural resources and habitats. Minimize use of fencing and where fencing is required, use designs that allow for wildlife passage.

(5) **Protect water quality and avoid erosion.** Utilize Stream Smart road/stream crossings, proper erosion control techniques, and minimize the number of stream and wetland crossings to the greatest degree possible. Provide adequate buffers around wetlands, vernal pools, and other aquatic systems to allow for the natural functioning of such systems, including retaining shade for streams and providing travel corridors for multiple fish and wildlife species. Adopt stream protection standards for buffers and cutting developed by the Maine Department of Inland Fisheries and Wildlife.

(6) **If development is proposed in a greenfield site[4] or away from existing infrastructure, evaluate potential cumulative impacts, including existing development and potential future development for a site.** This includes the amount of impervious surface and amount of vegetation clearing in the area.

(7) **Restore or maintain native vegetation in the project area, including "pollinator friendly" species, and avoid where practical, and minimize as much as possible, the use of pesticides and/or herbicides.**

1. Brownfields are properties, that, if redeveloped or reused, may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.
2. Maps for these areas can be found through the statewide Beginning with Habitat program.
3. The location of these habitats can be obtained through the Maine Department of Inland Fisheries and Wildlife, Maine Department of Marine Resources, Maine Natural Areas Program, federal agencies, and local non-profit organizations.
4. A greenfield site is a site that has not been previously developed or otherwise degraded.

Agricultural Siting Best Practices

If it is determined that agricultural land is a responsible site for solar power, the following should be considered to mitigate impacts to the future productivity of the land:

(1) **Where possible, avoid land identified by the Natural Resources Conservation Service as "Prime Farmland" or "Farmland of Statewide Importance," or otherwise cause productive farmland to be taken out of production, including land leased for agricultural uses.**

(2) **Preferentially use previously-developed, disturbed, degraded, or marginally productive portions of the farm property.** This includes rooftops, land within and around farmstead areas, sand and gravel pits, and other areas with low utility for agricultural production.

(3) **Encourage dual-use projects, where agricultural production and electricity production from solar installations occur together on the same piece of land.**

(4) **Build, operate, and decommission projects in ways that preserve the ability for the land to be farmed in the future and that do not inhibit access to or the productivity of farmland surrounding the solar installation.**

(5) **Minimize the impacts of grid connection on the agricultural resources of the property.**

(6) **Where applicable, projects should benefit the farm business directly by providing electricity to meet the energy needs (in whole or in part) of the farm.**

Best Practices for All Solar Development

(1) **Use a proactive approach to community engagement.** In general, Maine people overwhelmingly support solar power. As specific solar projects are proposed in greater number, at larger scale, and in and around communities, it is important to educate and listen to community members about individual projects as early in the development process as feasible. Informal presentations or open houses are often more effective for genuine engagement than the processes required for local permitting.

(2) **Provide municipalities and community members with information about the performance and beneficial outcomes of projects.** Project owners are encouraged to provide information about project performance or outcomes before, during, and after construction. Information can include: energy generation, financial savings, employment/spending, property tax payments, emission reductions or similar metrics. This information can be shared through signage at the project, newspaper articles, or updates to local government officials.

The rural town of Plainfield is located in the highlands of Western Massachusetts at the head of two watersheds. Plainfield is home to a small but active community, whose members are passionate about the dense forests, rolling fields, and fast-flowing streams that shape the landscape. In recent years, the community has begun to feel the effects of climate change, and acknowledges the importance of land use decisions in determining Plainfield's resilience to these changes. The Town wishes to be proactive in planning for climate change and seeks to bring together previous town studies and recommendations to create a long-term vision for the community. This Climate Resilience Plan evaluates current land uses and systems that contribute to resilience in Plainfield—spanning food systems, natural and cultural resource conservation, and green energy—and provides recommendations for increasing resilience across the natural and human landscape.

This project was funded through the Massachusetts Executive Office of Energy and Environmental Affairs.